Research and mentoring programs support chemistry undergrads In Puerto Rico [1]

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By:

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GO-GETTER Diaz Maldonado landed a sales job at instrumentation firm Leco after earning a B.S. from UPR Mayagüez and a Ph.D. from Purdue. Credit: Linda Wang/C&EN

Born in the mountainous central region of Puerto Rico, Johary Rivera-Meléndez was inspired to study chemistry through the urging of her high school chemistry teacher in Orocovis. However,

after being accepted at the University of Puerto Rico, Río Piedras, it was the support she received from her professors that helped her keep that dream alive. “It has not been an easy journey, but I have had amazing people around me who have motivated me to keep on going,” says Rivera-Meléndez, who is pursuing a Ph.D. in electrochemistry in Héctor D. Abruña [3]’s research group at Cornell University.

“The chemistry program at UPR Río Piedras is particularly small compared to many chemistry programs around the world, but its professors are relentless at making sure all of their students excel,” she says. They “opened the door to what was my first research experience, which is most certainly what led me to pursue my graduate degree in chemistry.”

Chemistry departments within universities in Puerto Rico have built a strong tradition of providing mentoring and rich research opportunities to their undergraduates. In part because of those efforts, these schools have been able to continue to attract and retain students despite serious budget constraints and cuts to federal programs that support the departments.

“Traditionally, resources such as materials and infrastructure in Puerto Rico have been more limited than in the rest of the U.S.,” says Francis B. Patrón [4], a professor and former chair of the chemistry department at UPR Mayagüez. “Yet our students—because of the environment in which they develop and the mentoring they receive—learn to do well with less.”

This is a photo of Stephanie Rivera doing research.

EARLY START

Like many other Río Piedras chemistry undergrads, Stephanie Rivera has been conducting lab research since her freshman year.

Even amid challenging economic conditions, the number of students graduating with B.S. degrees in chemistry from the UPR system has remained steady. According to the National Center for Education Statistics [5], UPR campuses in Cayey, Humacao, Mayagüez, and Río Piedras together produced the same number of B.S. chemists, 150, during the 2011–12 academic year as they did during the 2006–07 academic year. Private universities, in contrast, experienced a drop, producing only 78 bachelor’s degree chemists during the 2011–12 academic year versus 102 in 2006–07. One reason for the decline may be that fewer students have been able to afford tuition costs, which are about two to four times higher at private universities than those within the UPR system, says Angela M. González, chair of the department of biology, chemistry, and environmental science at Inter American University of Puerto Rico, San Germán.

At the same time, at least some chemistry departments in Puerto Rico are motivating students to extend their chemistry education. “Approximately 52% of our chemistry students continue postgraduate studies, 27% pursue graduate studies in chemistry, and almost 20% of our B.S. graduates complete their Ph.D.s in the field,” observes Ingrid Montes [6], a chemistry professor at UPR Río Piedras. Among all U.S. university campuses over the past five years, UPR Río Piedras ranks seventh in the number of its B.S. graduates who have earned chemistry Ph.D.s, and it’s the top in Puerto Rico, according to the National Science Foundation’s WebCASPAR [7] database.

On the island, mentoring programs and research opportunities augment rigorous chemistry educational programs, many of which are accredited by the American Chemical Society and rely on the same curricula and texts used in the U.S.

Within the UPR system, mentoring of chemistry students starts early. At UPR Mayagüez, for example, freshman chemistry students are introduced to the curriculum through a course that involves weekly mentoring meetings with professors, notes chemistry professor Doris Ramírez-Soto [8].

This is a photo of members of the UPR Río Piedras ACS student chapter.

CELEBRATION

Members of the UPR Río Piedras ACS student chapter share their enthusiasm for chemistry at the Festival de Química.

As students progress through undergraduate programs, many benefit from student-to-student mentoring programs. For example, students struggling through Montes' rigorous introductory organic chemistry course can get help from a legion of student volunteers made up of those who successfully completed the class a year earlier. In addition to providing tutoring, the mentoring students serve as role models for younger students, says Montes, who is a member of the board of directors of ACS, which publishes C&EN.

Within chemistry departments at both public and private universities in Puerto Rico, mentoring extends well beyond formal programs and classroom walls. "Our department is small, and students and professors are part of an academic family," says González. "We take a personalized approach to education, which makes our students feel respected and comfortable," she says.

"Our culture is very warm, and we really care about our students here," says Montes, who has a reputation for being a caring mentor and is fondly called Mother Goose by her students.

Juan Carlos Aponte-Santini is just one student who says he has remained focused on a career in chemistry because of Montes' guidance and support. As his organic chemistry professor, and later his graduate research adviser, Montes helped him morph from an undergraduate who was "afraid and uncertain about the future" to a graduate student focused on becoming a professor, he says. "She helped me believe in myself," says Aponte-Santini, who is completing a dual Ph.D. in chemistry education and organic synthesis.

This is a photo of Ingrid Montes and the U of Puerrto Rico, Río Piedras, ACS student chapter conducting a

DAZZLING

Montes and the UPR Río Piedras ACS student chapter conduct a "Magic of Chemistry" show for high school students in Puerto Rico.

Like countless other professors in Puerto Rico, Montes works hard to remain accessible to her students—many of whom either are single mothers or come from low-income families. Roughly 70% of students in the UPR system are recipients of federal Pell Grants [9], an indication that they

come from a financially deprived background, notes Ramírez-Soto.

“We try to open doors for these students and encourage them to continue in school or at least complete their bachelor’s degrees,” Montes says. Often, students want to learn about research opportunities or get guidance about summer internships, which provide not only valuable hands-on experience but also a source of income that will help them fund their education, she says.

Over the past five years, about 90% of chemistry students at UPR Río Piedras have gained some research experience while earning their bachelor’s degrees, she notes.


This is a photo of demonstrations during a National Chemistry Week celebration at UPR Río Piedras.

REACHING OUT

As part of a National Chemistry Week celebration, members of the UPR Río Piedras ACS student chapter perform outdoor demonstrations for high school students.

Universities in Puerto Rico offer many research opportunities thanks in part to funding sources such as the National Institute of General Medical Sciences (NIGMS) Research Initiative for Scientific Enhancement [10] (RISE) and Minority Access to Research Careers [11] (MARC) programs.

RISE offers opportunities for undergraduate- and doctoral-level students in chemistry and biology to actively participate in biomedical research projects in a variety of disciplines, including chemical synthesis, biochemistry, and photochemistry.

MARC is designed to provide undergraduate honor students with research activities and a special science curriculum aimed at improving their chances of being accepted into biomedically related doctoral programs. Thus far, 167 of the 300 UPR Río Piedras students involved in this program have completed their Ph.D.s., and another 103 are still pursuing them, according to Reginald Morales [12], a professor of chemistry there.

Unfortunately, students are receiving fewer program perks such as access to workshops and short courses from MARC and other honors research programs. The programs have been affected by budget cuts, mainly because of sequestration, over the past two years, says Ramírez-Soto, who is codirector of the UPR Mayagüez MARC program.

Despite the cutbacks, the programs continue to help students gain exposure to potential graduate programs or career paths.

Naomi Diaz Maldonado says her participation in research programs influenced her pursuit of a Ph.D. in chemistry. Being a part of a program, now known as the Purdue Summer Research Opportunities Program, in the early 2000s opened her eyes to the excitement of research—something she had not been exposed to as a biology undergraduate at UPR Humacao, which didn’t have lab facilities at the time.


This is a photo of students discussing research results with Ingrid Montes in the undergraduate lab at UPR

CLOSE CONNECTION

Students discuss research results with Montes in the undergraduate lab at UPR Río Piedras.

After finishing one of her three summers in the program, which involves intensive research with faculty mentors, she transferred to UPR Mayagüez, where she was able to pursue her love of research.

Through her participation in undergraduate research, Diaz Maldonado says she was able to explore different areas of chemistry and find her niche: solving biochemical problems, especially applying chemistry to human cancer treatments. The programs also helped her develop the skills she needed to secure a spot in the chemistry Ph.D. program at Purdue after graduating from UPR Mayagüez with a B.S. degree magna cum laude in 2004.

Diaz Maldonado earned a Ph.D. in analytical chemistry under Fred E. Regnier [13] in 2011 and landed a job in Dallas as a sales engineer in the separation sciences department at instrumentation firm Leco [14].

Carlos E. Crespo-Hernández says his participation in research programs made an indelible mark on his career plans.

While earning a B.S. in chemistry at UPR Río Piedras, Crespo-Hernández was accepted into the National Institutes of Health Minority Biomedical Research Support [15] program. It enabled him to perform research on the photochemistry of DNA and amino acid components for three years in chemistry professor Rafael Arce [16]'s group.

In addition, Crespo-Hernández did two summer research internships. Partly because of these undergraduate experiences, he says, "I recognized that I have a love and a passion for teaching and research and that I wanted to pursue a career as a chemistry professor." After completing a Ph.D. in physical chemistry under Arce in 2002 and a postdoctoral NIH fellowship appointment at Ohio State University under Bern Kohler [17], he began his dream career as an assistant professor at Case Western Reserve University in Cleveland in 2007.

Rivera-Meléndez also drew conclusions about her career aspirations as a result of her undergraduate research experiences. Under the tutelage of UPR Río Piedras chemistry professor Carlos Cabrera [18], she conducted research in electrochemistry and fell in love with the process. With Cabrera's encouragement, she applied to and was accepted to the NSF Research Experiences for Undergraduates [19] program. She spent a summer doing research at the University of Pennsylvania, and then at Cornell, where she first met Abruña, her current adviser. Through these experiences, she says, "I realized that solving current scientific problems and answering questions that have never been answered before are the most interesting things I can do in a future career."

As much as professors motivate their students to pursue degrees in chemistry, however, some are apprehensive about the state of the job market throughout the U.S., and especially in Puerto Rico.

One concern is that many chemistry and pharma firms could leave the island as a result of the 2010 passage of Puerto Rico's Act 154, which imposes an excise tax on multinational manufacturers with operations on the island. However, Antonio L. Medina Comas, executive director of the Puerto Rico Industrial Development Co. [20], says the tax has not had a significant impact on the island's industrial base. Through a variety of efforts, he says, "we have been able to retain those companies affected by the tax."

For her part, Rivera-Meléndez has no regrets about her decision to continue her chemistry education, she says, adding that "you can work chemistry into any industrial, governmental, scientific, or educational field." For now, "I will consider my options and not be too concerned about the poor state of the economy and the job market," she says. "Things will get better."

As professors in Puerto Rico, Ramírez-Soto adds, "we have the privilege to work with students who know they will benefit from higher education." Earning an undergraduate degree in chemistry "is not easy," she says, but with mentoring and support, "most are able to achieve that goal."

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