Point of View
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Raising Scientists

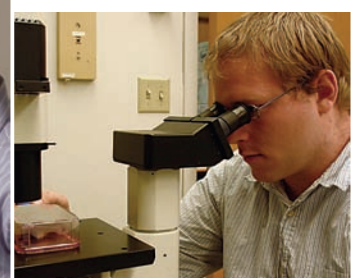
Just as a fledgling develops feathers and learns to fly, students can try their wings at becoming independent researchers through educational experiences afforded through laboratories. "The laboratory is about providing opportunities," says Arthur S. Polans, PhD, professor in the Department of Ophthalmology and Visual Sciences and Associate Director of the UW Eye Research Institute. "My goal as an educator is to build scientific independence," continues Polans. "I structure my lab as a place for students at every educational level."

Among the youngest trainees are the nine high school students Polans has hosted in his lab. While high school students can't usually comprehend the full scope of the scientific projects in the laboratory, they can be given a specific question to address during a summer apprenticeship.

Many of these high school students have gone on to pursue higher education in scientific fields. Hoda Ahmadi, currently a third-year UW–Madison medical student, spent two summers in the Polans laboratory as a high school student. "I had no biology background when I started," says Ahmadi. "But I had a small project that I completed in a summer, and I learned how to present my results."

She also notes that she was exploring medicine, pharmacy, and other career opportunities at the time. Now well into her medical training, she says, "I am much more aware of what happens 'behind the scenes' with each patient. I have a sense of the research that underlies the base of knowledge relevant to each medical condition and the treatments we apply. I think research will always be a part of my career path, thanks to my early lab experiences."

Students entering the University of Wisconsin–Madison find many opportunities to incorporate laboratory time into their curriculum. Polans serves as a mentor to undergraduate students



Graduate student Dhruv Sareen and Arthur Polans, PhD, plan an experiment, while Jason Kenealy, graduate student, checks cultured tumor cells, and post-doctoral fellow Lalita Subramanian, PhD, measures chemotherapeutic drug levels by HPLC.

through the Chancellor's Scholarship Program, a program designed to increase educational opportunities for academically talented underrepresented ethnic minority and disadvantaged students, and through the Undergraduate Research Scholars Program, which helps first- and second-year undergraduates get hands-on research experience through individually-designed mentored research projects.

Polans notes, "I watch undergrads develop independence over the course of a semester or two. They integrate what happens in the lab with their coursework, and they learn to take direction of a project. Students at this level can be expected to devise a hypothesis, design and conduct experiments to test their hypothesis, and interpret the results of their experiments."

"I've learned more about techniques and research than I learned in class. The class projects are like recipes in a cookbook, but my project in the Polans lab requires me to have a broader under-

Polans' lab members, from left: Jennifer Takach, graduate student, places bacterial specimens in an incubator; undergraduate Autherine Ikanih adds data to her lab notebook; Melkon DomBourian, medical student, treats tumor cells in culture; associate scientist Paul van Ginkel, PhD, reviews experiment with health technician and histologist Soesiawati Darjatmoko.

standing of what I am doing and why," says junior Mike Aberger. "Even when I have an experiment that doesn't work, I've learned to think through the steps of why it is not working. Should I change the incubation time, the drug concentration, or my technique? I can try my ideas and see what works."

Graduate students can focus on a question that is important to them, and can deftly run and interpret experiments. They also have the knowledge that allows them to adjust their direction after failures, and they learn to critique the research of others by reviewing research articles and grants.

Dhruv Sareen, a doctoral candidate in the Department of Biomolecular Chemistry, has been in the Polans lab for about three years. "In my undergraduate lab experience, I was focused on following procedures and getting results. Now I can appreciate the entire scope of a project, and that research is not necessarily about the number of experiments but about thinking each experiment through critically and recognizing how they connect to one another."

Initially, Polans asks his graduate students to draft a mock publication as a template for their project. The student determines what techniques will be used, what figures and charts will be required, and what analyses will be necessary to support their conclusions. The student then presents the "publication" to colleagues at a lab meeting, and receives the suggestions and criticisms of the group. "This process shapes their critical thinking," says Polans. "The students think through the research question from start to finish, and as a result, are more focused on gathering the information they need instead of running experiments that won't answer the question."

Every truth has four corners: as a teacher I give you one corner, and it is for you to find the other three.

Confucius

"At first I was intimidated by the critiques," adds Sareen, "but I've learned to accept criticism, and as I've matured scientifically, I am able to critique others in a helpful way."

The last stage of education for a scientist is often post-doctoral training, a period of advanced training in a particular area. "Post-docs," as these individuals are fondly known, still benefit from the mentoring of their advisors, but they begin to take leadership in shaping and directing projects, are given oversight responsibilities and train others in the lab, and write grants related to their own work.

Lalita Subramanian, a post-doctoral scientist, says, "This is an opportunity for me to apply my PhD training and to learn more about my own approach to research. It's a time when I can focus on the science, and not the other academic requirements. I can choose an area of work that will carry forward into my ultimate career, and I can focus on an area that furthers my thinking in that field."

Polans summarizes, "Laboratories provide opportunities for education, for collaboration, and for learning about disease. Making a positive impact on health care is an important goal. But helping vision science researchers grow and mature is one of the most important aspects of my job. They are the ones who will advance scientific knowledge in the future."

THE UNIVERSITY *of* WISCONSIN MADISON

The UW Eye Research Institute
445 Henry Mall #307
Madison, WI 53706
608/265–0690
info@vision.wisc.edu