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As the nature of scientific inquiry has become more interdisciplinary, and the range of job expectations for new scientists has radically changed, UVM has reshaped the pathways that lead promising students into careers in biomedical research.

It’s a question on the minds of research scientists the world over: When is that ‘aha’ moment going to happen? When will the pieces fall into place, leading to a new discovery that changes how we understand the biology of a human, treat disease, or care for patients?

“The backbone of discovery science is still the lone investigator at 2 a.m. wondering what something means,” says UVM Professor of Medicine Richard Galbraith, M.D., Ph.D., associate dean of patient-oriented research. What has changed is how that person fits into the larger whole. Interdisciplinary teams that look at questions from different angles are becoming more and more vital to scientific inquiry, says Galbraith, who is also the director of the UVM Center for Clinical and Translational Science. And with technology — especially the power of computers to analyze vast quantities of data — transforming what is knowable, scientists must be grounded in their discipline while also understanding its relevance to other fields.

To keep pace with this new reality, UVM and other institutions are re-thinking how they educate research scientists. Today, students entering a Ph.D. program affiliated with the College of Medicine choose from four programs that bring faculty together from multiple departments and colleges across the university — all under the administrative umbrella of the UVM Graduate College. Several programs have been restructured and combined to give students exposure to a wider variety of research, while a few new programs — clinical and translational science, and bioengineering — have been created to address relatively new fields. In all of these programs, students conduct their Ph.D. research with mentors who...
The world is more complex now. We need scientists who can connect the socioeconomic conditions, even the built environment, to the science. People who are professional scientists now are extremely lucky," she says. "Science is opening up new ways to ask questions." At the College of Medicine, four Ph.D. programs serve as pathways to careers in the biomedical sciences: Cellular, Molecular and Biomedical Sciences; Neuroscience Graduate Program; Clinical and Translational Science; and the Neuroscience Graduate Program.

Cellular, Molecular and Biomedical Sciences

The most recent change in the graduate medical sciences at UVM is the merger of four College of Medicine graduate degree programs — microbiology and molecular genetics, molecular physiology and biophysics; biochemistry; and pharmacology — with cell and molecular biology. The new expanded program has a different name — cellular, molecular, and biomedical sciences — but a familiar acronym: CMB. Those three initials have stood for over 40 years for students with biomedical training, outside of academia are snapping up tenure track faculty positions — essentially the jobs that Ph.D.s were responsible for saving many lives. But it is having its limitations. What happens in a test tube does not necessarily hold when it is part of a larger system, notes Associate Professor of Molecular Physiology and Biophysics Chris Berger, Ph.D., director of graduate education at the College of Medicine. And then there's the realization that science doesn't end with what happens in the lab — public policy decisions, socioeconomic conditions, even the built environment affect health outcomes. "The world is more complex now," says Berger. "We need scientists who can connect the dots, and ask the right questions."

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by the NGP and UVM’s physical therapy program allows students to pursue both degrees, opening up exciting opportunities. Students are required to be a teaching assistant in at least two courses — setting an expectation for strong communication skills. Many NGP students work with undergraduates who come to campus for the Summer Neuroscience Undergraduate Research Fellowship Program (SNURF), which is funded by the National Science Foundation and the College of Medicine Office of Diversity and Inclusion. An essential feeder program for NGP, the success of SNURF is reflected in the diversity of the program — 21 percent of NGP students are from underrepresented minorities, compared to 5.6 percent of all grad students at UVM.

NGP students Vanessa Ochoa and Liana Merrill have honed their communication skills through these and other activities. Although both are spearheading important research — Ochoa works with Nishi researching neuroblastoma in children, and, with Margaret Vizzard, Ph.D., Merrill is focused on studying how the brain controls bladder function. Both students envision a future that also involves teaching. As a Mexican-American who is the first in her family to continue to professional school, Ochoa would like to work with minority students. Merrill hopes to teach at a liberal arts college or small university.

“Teaching is a lot of work but it is really rewarding to inspire someone who is younger than you,” says Ochoa. Adds Merrill: “I feel like the outreach we do here is abundant. That makes us stand out from other programs.”

Clinical and Translational Science
Graduate students in the Clinical and Translational Science (CTS) program bring with them expertise in a wide variety of subjects: The program attracts internists, radiologists, surgeons, and computer scientists, even lawyers and anthropologists. What unites them is a desire to apply their knowledge to health care in a research setting.

This was the case for Abigail Crocker, a faculty member in the mathematics and statistics department at UVM with a master’s degree in bioinformatics. She wanted to use her expertise to become an independent investigator, and in CTS found not only strong mentors, but a group of students who provided support and guidance.

“We learned a lot from talking to each other about how to systematically approach research studies,” says Crocker, who defended her dissertation in April of 2013. “When you leave the program you should be an expert in the research process.”

For a long time, students and faculty at UVM looking for this kind of mentoring sought it out through an informal network, at the intersection of fields. Launched about two years ago, the Ph.D. program now includes six students with mentors in the College of Medicine and the College of Engineering and Mathematical Sciences. Students apply quantitative engineering analysis to the study of biological systems, which may range from molecules all the way to populations.

“Bioengineers are in pretty big demand,” says Bates, who is a professor of medicine and interim director of the School of Engineering. Recent advances in the development of artificial organs and tissues have grabbed headlines, while the ever-increasing volume of data humans produce has prompted new thinking about how to aggregate this information to help transform this loose network into an interdisciplinary team of researchers — including pulmonologists, professors of medicine Dan Weiss, M.D., Ph.D., associate professor of medicine Matthew Pouyner, Ph.D., and Bates — to create a computer model that predicts how cells in the lung respond to certain allergens. The goal is to understand why some people, particularly children, suffer from chronic asthma while others may have only a few attacks and recover. Because a computer model has the ability to simulate a complex system, it stands to capture the emergent behavior that comes from parts interacting as a whole. This knowledge can inform the direction bench research takes, allowing scientists to test big ideas before going to the lab. Huge advances in technology and data analysis have made this work possible. Pothen says, and bioengineers stand uniquely poised to make connections between computer modeling, lab research, and patient care.

“It takes someone who can connect the researcher and the clinician and say ‘hey, you could use this,’” Pothen says. With bioengineering faculty working on everything from tissue engineering and regenerative medicine to orthopaedic biomechanics and synthetic biology, collaboration is a part of everyday life. Faculty members hail from and work with the Advanced Computing Center, the Vermont Cancer Center, the Department of Rehabilitation and Movement Science, the Division of Cardiology and many other departments and programs across campus.

“The program brings engineering and medicine together in ways that wouldn’t have happened otherwise,” Bates says.

Like Pothen, students in all of the graduate medical science programs at UVM learn critical thinking, research, and teaching skills, and they learn prepared to enter a job market that is rapidly changing. Most important, they’re also prepared to explore the unknown in science, and contribute new knowledge to their fields, says Chris Berger, Ph.D.

“New ideas come from synthesis, from thinking about a problem differently,” Berger says. “That’s where most scientific progress is made.” And where the next generation of scientists emerge. 

Clockwise from above right, Rux Nohl, Ph.D., Professor of Neurological Sciences and director of the Neuroscience Graduate Program, graduate student Liana Merrill, graduate student Vanessa Ochoa (in lab coat) works with SNURF program participant Genevieve Rankin, Abigail Crocker, Ph.D. (not 2013 www.edu/vt http://www.snrp.org).data on her laptop with Associate Dean for Primary Care Charles MacLean, M.D.

At top, graduate student Joshua Pothen works with a cross-disciplinary team of mentors to create a computer model of lung cell response to allergens. Below, Professor of Medicine and Interim Director of the School of Engineering Jason Bates, Ph.D., is one of the mentors of Joshua Pothen and other students.

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