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Graduate Education in Chemical Biology at the University of Michigan

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Around the country, chemical biology is increasingly recognized as a focal point for understanding biology at the molecular level—where modern biological and biomedical research is pursued from a uniquely chemical perspective.

Research in chemical biology has been conducted at the University of Michigan for many years in several departments, including biological chemistry, biophysics, chemistry, medicinal chemistry, and pharmacology. Historically, no single program provided large numbers of faculty working in this area. Moreover, graduate training in chemical biology within individual departments often forced students to conform to existing departmental guidelines that may not have been appropriate for them. This meant that in some cases it was difficult for students to get the training they needed.

In response to the need for specific graduate education in chemical biology, a new interdepartmental doctoral program was initiated in 2004. The program is essentially a virtual department and leads to a Ph.D. in chemical biology. Alternative models, in which students apply to an umbrella recruiting program that allows them to select from several departments to do their Ph.D. work after they matriculate, are used by several institutions (including Michigan for the biomedical sciences). Although such a model opened the door for more thesis advisers for students to choose from, we selected the virtual department to ensure that students in the program receive

a high-level, cohesive graduate experience; that the program would have full control over the graduate curriculum; and that a level of research collaboration and mentorship is enabled that is not possible in existing departments. Our program faculty (now ~40) is drawn from seven departments across campus. Students entering the Michigan chemical biology doctoral program are free to choose any of these faculty or groups of faculty as thesis mentors, and this allows them access to most laboratories on campus that do chemical biology research. Our faculty members have a diverse group of interests covering nearly all areas of what can be described as chemical biology.

A major challenge in designing our program is that “chemical biology” means different things to different people. Thus, entering students have varying backgrounds and diverse interests. Rather than trying to impose a specific vision of what chemical biology should be, we have taken a very open attitude. The chemical biology doctoral program at Michigan is structured to maximize the flexibility a student has in designing his or her curriculum and to place the key decision points in the hands of the students. A sequence of two core courses is required; a minimal list of topics is covered that we believe every chemical biologist



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should know, including macromolecular structure and folding, molecular recognition of small and large molecules, catalysis, protein biosynthesis and degradation, signal transduction, combinatorial synthesis, screening, and chemical genetics. In this course, each topic taught includes examples of how both chemists and biologists have addressed the problems being discussed (*e.g.*, use of small molecules and structure-function studies). Two literature-based discussion courses are also required. Beyond these prescribed courses, students fill their remaining credit requirements with whatever courses interest them from the broad range offered throughout the university. In this way, students are free to tailor their coursework to suit their own interests and visions of what chemical biology is.

Although a flexible curriculum is important, research is at the heart of any Ph.D. program. The structure of the chemical biology Ph.D. program emphasizes research training from the beginning. Students are supported by the program in their first year as research fellows, during which time they complete a minimum of two research rotations, which can begin the summer before they matriculate. These rotations generally last a semester, but students have the option of splitting them into half-rotations, maximizing their exposure to research in the labs of different faculty. By April of the first year, students select a faculty thesis mentor and start their thesis work. Students are not required to work as teaching assistants at any time in the program, although arrangements can be made for those desiring that experience. The progress of the students toward their degree is monitored by annual meetings with their thesis committee and with the program leadership team. The program is structured to minimize distractions from research with the goal of having students defend their thesis research within 5 years. Another challenge for a program that spans a large, diverse campus like Michigan is keeping a sense of identity and

coherence both for the faculty and students. This problem is somewhat mitigated because the laboratories of the participating faculty are within walking distance of each other. To further build esprit de corps, the program sponsors monthly lunches for the students. In addition, the members of the steering committee have dinner with all the students twice a year and involve the students in decisions about their training. For example, many of our students are interested in working in more than one lab for their thesis research, so we recently established mechanisms for joint mentorship and collaboration within the program. Such joint mentorship fosters collaborations among program faculty and allows students to create thesis projects that span specialties and reflect the cross-disciplinary nature of research in chemical biology.

How successful are we? Only time will tell, but as we move into the second year, results are extraordinarily encouraging. A class of 6 from around the U.S. matriculated in the first year, and a class of 16 will be entering in the fall of 2006. This puts our program on track to reach its target of 22 *new* students per year in 2007. Our students come from top undergraduate institutions throughout the U.S. and include two students from Western Europe and one from Asia. Their academic credentials as a group place them among the best graduate students in the sciences at Michigan! Much of the success must be attributed to the active involvement of all program faculty in teaching, recruiting, mentoring, and social events. Constant feedback from the students has also been extremely important, allowing us to develop a program that truly meets the needs of our graduate cohort. Finally, our program could not have flourished without the support of the chairs of the participating departments, their respective deans, and the senior administration at Michigan, plus very significant funding to get the program started.

What was attractive about Michigan's chemical biology program? The inaugural

students enrolled in chemical biology were drawn here for numerous reasons. The exciting science being pursued by individual professors, the reputation of the University of Michigan, and the enthusiasm shown by the faculty members and their strong desire to work together across departments to create a successful Ph.D. program are just a few of the key factors. To paraphrase one student: "I feel like I've made an excellent choice. The scientific diversity of the faculty in the program challenges you to become fluent in both the language of biology and that of chemistry. Additionally, the faculty members are as committed to our professional development and success as they are to growing a top-notch chemical biology program that will continue to make important scientific contributions at the crossroads of chemistry and biology."