Program in Quantitative Biology and Modeling

Guidelines for Interdisciplinary PhD Programs between Biochemistry/Biology and the Physical/Mathematical/Computational Sciences

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Motivation

There is a national consensus that much of the university education system is entrenched along traditional disciplinary lines, while a great deal of academic research, industrial activity, and job opportunities require a broader educational background. For interdisciplinary science to be most effective, a key component will be bridging the communication gap between biologists and physical/mathematical/computational scientists. Without real communication we will be doing the obvious, which everyone can identify. But our goal must be to break new ground and develop research areas that are unique and competitive.

The dual degree programs and Program in Quantitative Biology (see http://biomodel.msu.edu) are designed to promote more, and more effective, synergistic interactions across the Engineering/Computer Science/Physics/Math/Chemistry/Biology interfaces, and at the same time to train a new breed of student who can really speak two languages, understand two cultures and therefore catalyze these interactions. To fill this need, we have initiated joint PhD training programs. For each student, the program centers on an interdisciplinary research project with a primary advisor in the student's major department and a secondary advisor in the second department. The joint program, as outlined below, has recently been approved by the Departments of Physics & Astronomy, Chemistry, Computer Science & Engineering, and Chemical Engineering. Such joint training programs will be extended, where appropriate, to other departments. We have designed the following guidelines to cover such pairings, with the aim of forming an umbrella Program in Quantitative Biology. *It is envisioned that such a training program will attract exceptional students. The primary goal remains to provide a training program that will make the students more innovative scientists who are highly competitive in the job market.*

Program Outline

Under current university guidelines, research-based graduate degrees can be designed across disciplines/graduate programs, with the concurrence of the graduate programs involved (see “Dual Major Doctoral Degrees” in the MSU Academic Programs Guide). The template for interdisciplinary graduate degrees we have developed and implemented (between Biochemistry and Physics & Astronomy; Biochemistry and Chemistry; Biochemistry and Computer Science & Engineering; and Biochemistry and Chemical

Engineering) involves two departments (Biochemistry or another biological science, and a physical/mathematical/computational science) with one being the student's primary affiliation (and home of the principal advisor), and the other a secondary affiliation (home of a secondary advisor or collaborator). Admission requirements to graduate school are those of the primary department. The student's coursework is split 60%:40% between the primary and secondary departments, with no more than 125% of the typical course load of a single Ph.D. degree being required for the interdisciplinary degree. The degree is called, for example, a Ph.D. in "Biochemistry and Physics", when the primary affiliation for the Ph.D. is Biochemistry and the secondary affiliation is Physics. Obligations for teaching are met in the primary department. Comprehensive (preliminary) exams are also arranged according to the guidelines of the primary department, and must meet the standards of a guidance committee that includes members from both departments, with ~60% of its members (typically three) from the primary department and ~40% (typically two) members from the secondary department. A project-based preliminary exam like the one in Biochemistry is ideally suited for this. If a student decides to leave the interdisciplinary degree program, he/she can revert to the requirements of his primary affiliation. A student can be admitted as an interdisciplinary degree student with concurrence of the two departments, but currently it is typical that he/she is admitted into the primary program then arranges the secondary affiliation upon choice of a research project.

Course Requirements

Consider the following as a sample template for an interdisciplinary Ph.D. program in which Biochemistry is either the primary or secondary department, and replace as needed by the relevant information for the departments of interest.

A typical course plan for a traditional Biochemistry Ph.D. student is BCH 801 (3 cr), 802 (3 cr), 803 (2 cr), 821 (3 cr), 829 (2 cr), 978 (1 cr, taken for approximately 3 cr total), and NSC830 (1 cr), with additional courses as advised by the guidance committee to complement the student's research. The following interdisciplinary coursework requirements are based upon requiring no more than 125% of this 17-credit traditional plan (with the exception of Chemical Engineering, in which students take up to 36 credits for the Ph.D.) and reflect the 60%:40% coursework ratio desired for interdisciplinary Ph.D. training.

- ***When Biochemistry is the primary affiliation***: At least four graduate courses will be taken in Biochemistry, usually at the 800 or 900 level, totaling 12 (or more) credits. Rotation requirements are flexible, especially if the student decides on a joint program at the outset, and teaching responsibilities are the same as for a traditional Biochemistry Ph.D. student. At least three courses (9 or more credits) will be taken in the secondary area, e.g., Physics, with at least two of the courses at the graduate level. When Chemical Engineering is the primary affiliation, the five Chemical Engineering core courses (15 credits) will be taken, plus other Chemical Engineering courses recommended by the student's Ph.D. Advisory Committee and approved by the Departmental Chair. At least three courses (9 or

more credits) will be taken in the secondary affiliation, of which at least 6 credits must be at the graduate (800 or 900) level.

- ***When Biochemistry is the secondary affiliation***: At least three courses (9 or more credits) of Biochemistry coursework, with at least two of the courses at the graduate (800 or 900) level. When Chemical Engineering is the secondary affiliation, at least three courses (9 or more credits) of Chemical Engineering courses at the graduate 800 level (i.e., three of the following courses 801, 821, 822, and 831) will be taken, and other Chemical Engineering courses as recommended by the student's Ph.D. Advisory Committee. Rotations and teaching responsibilities will be determined by the primary department, in accordance with the above Program Outline.

University Guidelines on Pursuing Interdisciplinary Ph.D. Degrees

Dual Major Doctoral Degrees

All dual major doctoral degrees must be approved by the Dean of The Graduate School. A request for the dual major degree must be submitted within one semester following its development and within the first two years of the student's enrollment at MSU. A copy of the guidance committee report must be attached. The following conditions must prevail:

1. **The intent to receive the degree in two areas must be outlined in the guidance committee report.**
2. **The content of the guidance committee report must reflect the required standards for both departments.**
3. **The course work must be satisfactory to both departments.**
4. **The comprehensive examination must be passed to the satisfaction of both departments.**
5. **A guidance committee including members from both departments must be satisfied that the dissertation represents a contribution meeting the usual standards in both areas.**