

THE CELL BIOLOGY PHD PROGRAM

Over the past several years, the Cell Biology Department has been systematically reviewing its PhD program. Although initiated independently of the Graduate School's 2-4 Project, our review has focused on some of the same concerns as that project, in particular the timely completion of the dissertation. This report summarizes some significant changes to the PhD program that have been made so far as a result of our evaluation, which is still ongoing.

Thesis committee meetings

Students in Cell Biology usually begin thesis research in their 2nd year of graduate school. As the course requirement in Cell Biology is minimal (see below), nearly all students fulfill both the departmental and the Graduate School's Honors requirements in the first year and therefore can dedicate the remaining years to thesis research (not counting the time taken to fulfill the requirement for 2 semesters of teaching). During the thesis research years, students have only two other departmental requirements. One is to present once a year, beginning the 3rd year, a talk about their research to the entire department at the Friday "Progress Report" series. The other requirement is to have a thesis committee meeting at least once a year.

Thesis committee meetings play a critical role in monitoring and ensuring the progress of a student's thesis research. However, several problems with the current system of thesis committee meetings have been observed. First, not all students have annual thesis committee meetings, sometimes because a student repeatedly postpones the meeting in order to obtain more data, which usually takes longer than anticipated to materialize. Second, thesis committees may allow a student to flounder too long on unproductive projects before stepping in to help define a viable thesis project. Specifically, thesis committees may wait till the end of the 5th year to take such concrete action, which leaves only a year for the student to develop and complete a thesis project by end of year 6. Finally, the current system does not provide students or even thesis committee faculty with any guidelines for assessing whether appropriate progress is being made to complete the dissertation in 6 years or less.

To address these shortcomings, the following changes with regard to thesis committee meetings will be implemented beginning the 2007-8 academic year:

- 1) The requirement for an annual thesis committee meeting will be strictly enforced, as at least one meeting per year will be required for registration in the following year. The meeting should be held by May 31st, which is chosen as the deadline because the faculty will devote the June

faculty meeting of every year to a review of the progress of all students in the program. To put students on the track of regularly scheduled thesis committee meetings to occur by the Spring term of each year, the first meeting will be held toward the end of the 2nd year. Currently, the first thesis committee meeting usually does not occur till the end of the 3rd year, nearly 2 years after a student has begun thesis research. To be able to have a thesis committee meeting by the end of the 2nd year, the qualifying exam will be moved up from the Spring to the Fall of the 2nd year (as described in more detail below). This change would allow students up to 6 months or so to determine the feasibility of the project described in the qualifying exam proposal.

2) Students and thesis committee faculty will be provided with a guideline for assessing whether research is progressing adequately toward the goal of finishing the dissertation in 5-6 years. Described below is such a guideline in the form of an idealized timeline of benchmarks that can be used to evaluate progress at the end of each year. *It should be emphasized, however, that every student's thesis project is different and will not progress exactly according to the timeline as outlined.* The benchmarks are intended to serve as intermediate goals that students can strive to reach each year in order to reach the final goal of the completed dissertation within the timeframe of 5-6 years. Having such a defined timeline of benchmarks provides structure to the thesis research period, which otherwise may be overwhelming due to its open-endedness. Just as importantly, it should help thesis advisors in taking the appropriate responsibility and action to ensure that their students are making good progress toward timely completion of the dissertation.

Timeline of benchmarks:

2nd year: Student should be able to demonstrate that the project described in the qualifying exam proposal is feasible and worth pursuing further (for example, a key assay necessary for the project should be working). Otherwise, student should present a research plan for a new project, including any results that may already have been obtained.

3rd year: Student should be able to show that they are making progress on a research project that could lead to a thesis. Ideally, experiments should be working and have produced at least one positive result that could be the basis for a “story” with further experiments.

4th year: Student should have a concrete plan for finishing by end of year 6 or earlier. Ideally, this would correspond to an outline of a manuscript (even if it is just one key result plus a set of planned experiments) along with a timetable for completing the manuscript. If this is not possible, the student in consultation with the advisor should present an alternative project that in principle could be completed in the next 12-18 months. The committee may allow the student to

continue on the current project for another 3 months at most, after which time the committee will evaluate whether the student should continue on that project or start an alternative project.

5th-6th years: Student will present a completed manuscript and an outline of the dissertation to the thesis committee. Committee can then give student the go-ahead to write up the dissertation.

Currently, many students in the 5th year and beyond have more frequent than annual thesis committee meetings to ensure that they remain on track toward finishing. The Department has yet to decide whether more frequent meetings, such as one in the Fall and one in the Spring, should be required of all students beginning in the 4th or 5th year.

Student's summary:

Students will still be required to prepare a short summary (2 pages at most) of past work and future plans (with timetable) to distribute to the thesis committee before a meeting. However, one criticism is that such a summary in isolation makes it difficult for the thesis committee to evaluate whether progress has been made since the last meeting. To address this problem, students will be required to add the new summary to the summaries of previous meetings to generate a continuous record. Copies of this continuous record should then be sent to the committee members and to the DGS at least 1 week before the meeting. This would provide enough time for the committee and the DGS to determine if the report is adequate to hold the meeting; if not, the meeting has to be postponed until the report is satisfactory.

Committee's evaluation:

Currently, a report of the thesis committee meeting is prepared by the chair of the committee and sent to the student, other members of the committee, and the DGS. The report is usually brief, consisting of a paragraph or two of narrative. The Department has yet to evaluate whether instead the report should be a standardized form consisting of a checklist of questions to be addressed. Whatever mechanism is used for summarizing the thesis committee meeting, it is recognized that students are best helped by candid feedback about their work and progress.

Qualifying exam

Up to now, the qualifying exam in Cell Biology has been held in the Spring term of the 2nd year. The qualifying exam consists of a written research proposal on the prospective thesis project, 2 reading periods in which the literature of 2 fields broadly related to the thesis project is studied with 2 members of the qualifying exam committee, and an oral defense of the research

proposal. Students arrange the schedule for their exams but are expected to complete the exam by July 1.

Beginning with the 2007-8 academic year, the qualifying exam will be moved up to the Fall semester of the 2nd year. The exam will still be centered on a research proposal of the prospective thesis project. However, no preliminary data will be expected or required. Reading periods will also not be required, but students will still be expected to be knowledgeable about at least 2 areas broadly relevant to their thesis project and are encouraged to meet with members of the qualifying exam committee for guidance and advice about investigating those research areas. Not having required reading periods should facilitate timely completion of the qualifying exam, as scheduling problems caused by faculty availability should become less of an issue.

Rationale for the change:

The change to the qualifying exam is being made to address a number of perceived shortcomings of the previous system. A major concern was that students lose momentum in their thesis research by having to take time off for the exam that may not be completed till the end of the 2nd year, almost a year after beginning thesis research. Students may also tend to delay the exam as much as possible in pursuit of preliminary data, which they may feel is necessary to validate their research proposal. Having the exam occur earlier would prevent students from spending an unreasonable amount of time preparing for the exam, particularly in order to get preliminary data. Also, by explicitly stating that no preliminary data are expected or required, the qualifying exam can focus on whether the student can put together a good research proposal and defend it rather than whether the student's proposed project is actually working out and could be the basis for the dissertation (i.e., the prospectus). The latter issue can be evaluated at the first thesis committee meeting to be held at the end of the 2nd year. At the least, moving up the exam to the Fall allows students to engage in full-time thesis research without major interruption at an earlier time, which can only help to enhance the possibility of finishing the dissertation in 6 years or less.

General timeline for the new qualifying exam:

Summer (June-August)

1. Student will decide on a prospective thesis project. Student will assemble a thesis committee of 3 faculty members, excluding the thesis advisor, at least one of which must have a primary or secondary appointment in Cell Biology. This committee will also act as the qualifying exam committee.

2. In consultation with exam committee and thesis advisor, student will choose at least two research areas broadly relevant to thesis project that the student would be expected to be knowledgeable about from reading the literature. Student is encouraged (but not required) to meet with thesis committee members for advice and guidance in reading the literature and in developing the written proposal.
3. By September 1, the student will send to the exam committee and the DGS a 1-paragraph summary of the proposal describing the question to be addressed, why it is important, and how it will be addressed. In addition, the student will list the research areas that s/he expects to become expert on. The committee will then have 1 week to communicate to the student, via the chair of the committee, its approval of the thesis and research topics. A date for the oral exam in the Fall should be set.

Fall (September-December)

1. Student will write the proposal from summer to early fall. The proposal should be given to the exam committee at least 2 weeks before the oral exam. If the proposal is not satisfactory, the committee can postpone the exam.
2. Oral exam should be completed by the end of the Fall semester.

Students will arrange the schedule of their own exams within the timeframe above and are expected to complete the exam by the end of the Fall semester. Students needing extra time to prepare for the exam (for example, a student who did a 4th lab rotation during the summer) may be allowed to have an extension of the deadline or to take the exam in the following Spring term. Any exception must be endorsed by the thesis advisor and approved by the DGS.

Annual DGS meeting with students

Beginning with the 2006-7 academic year, the DGS instituted an annual meeting with groups of graduate students in the program. These meetings, held during the summer, are meant to be a forum to address the questions and concerns of students at two critical junctures in graduate study, at the beginning when they are about to join the program in the 2nd year and at the transition between 4th and 5th years. The consensus from a poll of students seemed to be that such a meeting with students in other years was not necessary.

There are two main objectives of the meeting with beginning students: one is to answer nuts-and-bolts questions about the program such as the qualifying exam and TA'ing, and the

other is to provide some general advice about graduate study and what it involves. Expectations are discussed along with the importance of regular thesis committee meetings, developing good communication skills, taking charge of your own project, working hard, etc. The Cell Biology Graduate Student Handbook has much of this information. Students are also given copies of a short article, "What makes a good PhD student?" (Nature, Vol 441, 11 May 2006, p. 252), which describes much of the same advice.

For the soon-to-be 5th year students, the main topics of discussion are what stage their thesis project should be and what they should be doing in the coming year to prepare for the future if they intend to finish by the end of the 6th year. Students going on to a postdoc, for example, should know about the process of securing a postdoc position and a fellowship, which all takes forethought and planning. That the 4th-to-5th year transition is the point to begin thinking about these issues will hopefully not come as a surprise to students, as the Cell Biology Graduate Student Handbook describes the timeline of milestones leading to completion of the dissertation in 5-6 years and the revised version to be completed this summer will include the information about yearly goals described earlier in this report.

Revised course requirement

The course requirement was changed beginning with the 2005-6 academic year. The old course requirement was: "Five courses are required: CBIO 602a, 727b, GENE 625a, MCDB 630b, in addition to one elective in one of the following areas: Genetics, Development, Neurobiology, Immunology, Microbiology, Pharmacology, Virology, or Molecular Genetics." The course requirement now reads: "Students are required to take at least 5 graduate-level courses. No specific curriculum of courses is required, but CBIO 602a (Molecular Cell Biology) is recommended for all students to attain a solid foundation in molecular cell biology. Also recommended is a seminar course, such as CBIO 603a (Seminar in Molecular Cell Biology) or CBIO 606b (Advanced Seminar Course), in which students can develop the skill for critical analysis of research papers. Students design their own curriculum of courses to meet individual interests and needs, in consultation with the DGS." Note that CBIO727b and CBIO606b represent the same course given different designations in alternate years so that students can receive credit for taking more than one semester of this seminar course in which the topics vary from year to year.

The change may be subtle but the main result is that no specific set of courses is required, and one reason for the change was to make our course requirement comparable to that of the Genetics and MCDB Departments. With these two departments, we formed several years ago

the Molecular Cell Biology, Genetics and Development (MCGD) track of the BBS from which our PhD program now draws the largest number of its students. During the first year, the core courses for first year MCGD students are CBIO 602a, GENE 625a, and MCDB 630b. Although considered core courses, they are recommended and not required, in recognition of the fact that some students might have had similar courses prior to matriculation at Yale and therefore could place out of any of these courses. However, Cell Biology, but not Genetics or MCDB, previously required all 3 courses in addition to a Cell Biology seminar course. The change to a more flexible course requirement comparable to the other 2 PhD programs reduces at least the perception of a more stringent course requirement, which may serve as a barrier to students in the MCGD track from choosing to join the Cell Biology program in the 2nd year. In addition, with the new course requirement, the typical MCGD student will fulfill the course requirement for Cell Biology in the 1st year, which promotes a quicker transition to becoming focused on thesis research.

New courses

Two new courses were launched in Spring 2006: CBIO 604b Systems Cell Biology and CBIO 701b Illuminating Cellular Function. These courses were designed to fill two major gaps in the study of cell biology as offered in our courses, which affect not only our own students but also more generally students in related areas of the molecular life sciences.

Systems Cell Biology:

Currently, by taking CBIO 602a Molecular Cell Biology, students attain a solid foundation in the molecular mechanisms and principles that govern the structure and activity of cells. However, this course does not teach about the structure, function and organization of cells within the context of complex multi-cellular systems as found in the human body. The overall aim of Systems Cell Biology is to provide an introduction to that knowledge, which is important for students to have if they are in the future to address a major challenge in biomedical science—an understanding of human diseases at the molecular and cellular levels. Systems Cell Biology is a core course in the new Medical Research Scholars Program at Yale, which recently received funding from the HHMI Med Into Grad Initiative for graduate programs that will produce a future group of PhD researchers capable of tackling research of more direct clinical relevance.

The Systems Cell Biology course is taught by a group of faculty from both Cell Biology and various clinical departments of the medical school whose collective research expertise spans a wide range of topics relevant to human biology. The topics covered in the course are essentially the same topics that would be covered in a 1st year histology course for medical

students, namely, the major tissues and organ systems of the human body, except the emphasis is on contemporary research on problems of human development and disease. The general format of the course is, for a given tissue or organ system, an introductory lecture followed by a more specialized lecture on a research topic. Integrated with the lectures are virtual histology tutorials where students use the computer to study the microscopic anatomy of tissues and organs. Systems Cell Biology was first offered in Spring 2006, and course enrollment in the first two years was 11-15 students, including 1st and 2nd year students from a number of different BBS tracks and PhD programs.

Illuminating Cellular Function:

Students in many different fields of molecular cell biology use various forms of light microscopy to visualize cellular and subcellular architecture. However, up to 2 years ago the Cell Biology Department did not offer a course on the fundamental principles and practical aspects of light microscopy. Partly in response to this gap, two Cell Biology faculty, Gero Miesenbock and Derek Toomre, created Illuminating Cellular Function. The goal of this half-semester course, which will be offered every other year, is to provide an introduction to the principles and methods of live cell imaging. The course covers the principles of widely used contemporary methods of fluorescence microscopy, and includes practical demonstrations of state-of-the-art instrumentation. Seven students enrolled in the course in Spring 2006, including not only Cell Biology students but also students from Biomedical Engineering.

Update to Cell Biology's 2-4 Project Report (December 2008)

This update summarizes the recommendations that were adopted or not adopted from Cell Biology's May 2007 report for the 2-4 Project.

Thesis committee meetings (pp. 1-3):

An annual thesis committee meeting is now required for registration in the following year. In the past year, when the requirement was first implemented, all students held thesis meetings.

We are still continuing to use a simple narrative report rather than a standardized form to summarize the thesis committee meeting.

The idealized timetable of benchmarks, as articulated in the 2-4 Project report, is not being provided to the thesis committees, mainly because some reservation was expressed that it might be perceived as promoting a minimal dissertation. Nonetheless, students can still find in the cell biology graduate student handbook an idealized timeline of major events so that they can have some guideline for assessing their progress toward the completed dissertation.

Qualifying exam (pp. 3-5):

The qualifying exam was moved up from the Spring to the Fall semester of the 2nd year, and a revised qualifying exam format was adopted. So far students have adapted to the new qualifying exam schedule and format without any noticeable problem. Any student wishing to delay the exam till the Spring semester may do so for valid reasons, and a few students have taken advantage of this flexibility.

The earlier qualifying exam made it possible to institute a new requirement for candidacy, which was not described in the 2-4 Project report. Now in order to be admitted to candidacy, a student must receive a positive evaluation of laboratory work at the 1st thesis committee meeting after passing the qualifying exam. Because of the earlier qualifying exam, the 1st thesis committee meeting can occur at the end of the student's 2nd year, which is beneficial because it encourages an earlier assessment of a thesis project's feasibility in addition to providing another opportunity for evaluating a student's performance.

New courses (pp. 7-8):

The Illuminating Cellular Function course about cellular imaging is not currently being offered, in part due to the departure of one of the organizers of the course. However, part of this course has now been integrated into a revamped Advanced Seminar in Cell Biology course, to be launched in Spring 2009, which will cover structural analysis in cell biology from the cellular to the molecular to the atomic level.