

CALIFORNIA INSTITUTE OF TECHNOLOGY

GRADUATE STUDENT INFORMATION

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Graduate Option in BIOCHEMISTRY & MOLECULAR BIOPHYSICS

DIVISIONS OF BIOLOGY & CHEMISTRY



INFORMATION FOR GRADUATE STUDENTS IN THE BIOCHEMISTRY & MOLECULAR BIOPHYSICS OPTION (BMB)

Introduction

This short handbook is a compilation of information about various aspects of the graduate program for the Ph.D. in Biochemistry & Molecular Biophysics (BMB) at Caltech, providing more detail than the *Institute Catalogue*. It is intended as a reference source that can be used whenever questions arise about policies and practices relevant to the program.

Administration of the Graduate Program

The following persons share responsibility for administering the BMB Option:

- Stephen Mayo is Executive Officer for the BMB Option, and his duties in that position involve general oversight of our program.
- Rob Phillips is the BMB Option Representative. The Option Representative is the person who the Dean of Graduate Studies considers to be responsible for the BMB option, and who is therefore authorized to sign petitions, candidacy forms, etc. The Option Representative is also responsible for planning the financial support arrangements for each student, and is the person to seek out if you have unusual problems that are not resolved through discussions with your advisor, advisory committee, or other colleagues.
- The Graduate Study Committee for the BMB Option consists of Stephen Mayo and Rob Phillips. Responsibilities include organizing student recruitment and coordinating the admissions processes.
- Alison Ross coordinates the administrative aspects of the BMB Option. Duties include details of financial support, admissions, publications, website maintenance, and records for BMB graduate students.
- Paul Sternberg is Program Director for our NIH training grant in Cellular and Molecular Biology. He is responsible for monitoring the progress of students who are receiving support from this grant, to ensure that they are making normal progress towards completion of the Ph.D.
- Kai Zinn is Program Director for our NIH training grant in Systems and Integrative Biology, which supports Neurobiology students in the BMB option.

Ultimate responsibility for your education rests with the Chairs of the Divisions of Biology and Chemistry, Elliot Meyerowitz and David Tirrell, and with the Dean of Graduate Students, Michael Hoffman. You should consider them to be available as resources if you need help beyond that provided by the others involved in the graduate program.

Together, these individuals advise the Option Representative on policies for the graduate program in Biochemistry and Molecular Biophysics (BMB).

Administrative Policies Related to Requirements for the Ph.D. Degree

Advisory Committees

Upon arrival, incoming students meet with the Graduate Studies Committee, who will assist the student in organizing rotations through several laboratories, and will also look at a student's past record and decide what additional course work is desirable. The Graduate Study Committee will counsel and oversee the student's progress upon admission to the graduate program.

Required Courses

BMB students are required to complete six advanced courses (100 level or higher, at least nine units each) with a grade of **B** or higher (only one course of the six may be taken with a Pass/Fail option). In the first year of graduate study, the course requirement consists of a sequence of three core courses covering topics in structural biochemistry (**BMB/Bi/Ch 170**), the molecular basis of protein function (**BMB 174**) and molecular genetics (**BMB 278**). These courses will expose the student to contemporary issues in modern biochemistry and to the tools and methods that are essential for biochemical research. In the first or second year, students should complete three additional advanced courses that are appropriate for their particular research interests.

At the discretion of the option representative, students may design their own core curriculum in their field of study that would serve to substitute for the three core courses with the idea that these advance courses (100 level or higher) are more relevant to the student's research interest. Suggested courses to consider for such substitutions are

ACM 100, Introductory Methods of Applied Mathematics
APh/BE 161, Physical Biology of the Cell
APh/BE 162, Physical Biology Lab
Phy 106 abc, Topics in Classical Physics
BE 150, Analysis, Design and Selection of Biomolecules
ChE/BE 163, Introduction to Engineering Biological Molecules and Systems
ChE/BE 164, Introduction to Statistical Thermodynamics
Ch 120 abc, Nature of the Chemical Bond
Ch 145, Bioorganic Chemistry of Proteins

Suggested Courses

Students are encouraged to take Bi 250 abc, *Adventures in Biology*; only one term may be used to satisfy the requirements for the 3 upper division courses.

GPA

Students must maintain a GPA of **3.0** at all times. In the event that a student's GPA falls below a 3.0, they will be placed on academic probation. Admittance to Candidacy requires a GPA of 3.0 or higher.

Rotations

In consultation with the Option Graduate Study Committee and individual professors, students will choose three laboratories in which to do short (10-12 week) research projects during their first year of residence. These laboratory rotations are designed to provide the student with an introduction to different areas of biochemistry. Research advisors are normally selected at the end of the first year. It is possible to waive some or all of the rotations by petitioning the Option Graduate Study Committee.

Liaison Group

A faculty-student "Liaison Group," consisting of several professors, the Option Representative, and several upper class students, will meet with the incoming students shortly after their arrival to answer general questions about the graduate program. This group will remain available for advice and consultation throughout the first year.

Qualifying Examination and Admission to Candidacy

By the end of the sixth term of residency (spring term of the second year), the student will take an oral examination to assess mastery of the field of biochemistry and to evaluate research progress. A Candidacy Examination Committee will be assembled by the student in consultation with his/her thesis advisor. The student is responsible for finding a date, time, and location for the exam. The committee should consist of the student's thesis advisor and three or four BMB faculty members (faculty outside of the BMB option may also be members of the committee), and is chaired by a faculty member other than the student's advisor.

As part of this examination, each student will submit:

- A written research report summarizing the progress in their research.
- An original research proposition in a field outside the student's chosen field of research. The committee chair should be contacted early in the Winter term to discuss the idea for the outside proposal in order to insure that the topic itself is acceptable.

Guidelines for the evaluation of such proposals are attached (See Attachment #1).

At the beginning of the winter term of the second year, students will receive a Candidacy package with the exam forms and procedures from the Option Coordinator. All forms must be returned to the Option Coordinator two weeks prior to the exam.

At the time of the proposal defense, the candidacy exam form will be completed by the Exam Committee indicating whether or not the student had demonstrated the capacity to do research. This evaluation will include, but will not be restricted to, consideration of the following:

- The motivation to think about complex problems, and devise creative approaches to solving them
- The motivation to find out what is going wrong with experiments when they don't work and to fix them
- Patience
- Perseverance in the face of difficulty and frustration
- The motivation to work hard
- A commitment to science as a high priority in life
- The capacity to become *engaged* in a problem
- The capacity to identify the most important aspect of a problem and the discipline to maintain experimental focus on the issue

When the student advances to candidacy upon successful completion of the exam, the Exam Committee will become the Thesis Advisory Committee and will meet with the student once a year to evaluate research progress. This committee will also serve as the Ph.D. Thesis Examination Committee.

In the event that there is inadequate evidence for the capacity to do research, the student may petition to allow postponement of admission to candidacy, for a period of up to six months (until December of the 3rd year of study). Both the Thesis Advisory Committee and the Option Representative must approve the petition. If there is a disagreement between the student and major professor (thesis advisor), the student may elect to switch to a different laboratory for the remaining six-month period to demonstrate the capacity to do research. Additional postponements beyond the end of the third year of study in the BMB Option would not be allowed except in extraordinary extenuating circumstances such as extended medical leave (i.e., the student must either be admitted to candidacy or asked to leave graduate school).

Thesis Advisory Committee meetings

All graduate students in the BMB Option are required to hold yearly meetings with their thesis committee. These meetings are to be held by 15 May of each year. If a meeting is not held in any given year, the student will be prevented from registering for the subsequent fall term. Compliance with this policy will be monitored by submission of a form that contains the

signatures of the thesis committee members present at each meeting, and submitting the completed document to the Option Coordinator. Exceptions to this policy, which can be granted only by the Option Representative, will be granted only in extraordinary circumstances.

Progress towards your degree

A graduate student who is making "normal progress" towards a Ph.D. degree can expect to continue as a registered student with full financial support. Normal progress should result in final selection of a laboratory in which to carry on your thesis research before the end of your first year in residence, passage of the qualifying examination in May of your second year, and completion of your Ph.D. within five years. However, we recognize that performing high-quality research is difficult, and that exceptions to these desired norms are sometimes necessary. In particular, extension of study beyond the fifth year is becoming increasingly common. Although your research should be planned for completion within five years, extension into the sixth year may be necessary if there are unexpected setbacks or delays in the research. Extension of graduate study beyond that necessary to complete a respectable Ph.D. thesis—simply to allow a student whose work has gone well to accumulate more publications—is not encouraged.

Institute regulations (as stated in the *Institute Catalogue*) require that you petition the Dean of Graduate Study for permission to register beyond your fifth year or if you have not been admitted to candidacy after three years. These petitions require the approval of the Option Representative for BMB, which will be given only if there is a positive recommendation from your Thesis Advisory Committee.

A faculty member who is supervising graduate students is expected to be informed about the progress being made by each of his/her students. In any case where a faculty member believes that a student is making less than normal progress, it is that faculty member's responsibility to communicate that opinion to the student, and to the Option Representative. Most faculty members will also want to commend their students when things are going well and reassure them when progress is slow, but within the normal range, etc.

One of the important functions of our system of initial Advisory Committees and Thesis Advisory Committees is to provide an opportunity for a wider evaluation of a student's work in any case where a student feels that his/her supervising faculty member's judgment of less than normal progress is unfair or incorrect. However, this system can only work if the supervising faculty member behaves responsibly in communicating concerns to the student, and if the student takes the initiative to involve the Advisory Committee, either by discussions with individual committee members or by meeting as a group. A more formal operation of this system occurs at the time of admission to candidacy for the Ph.D. degree and at the time of the final Ph.D. examination. However, the system is intended to function to prevent any surprises at these meetings.

A student may at any time apply to the Graduate Office to obtain an MS degree in addition to the Ph.D. program. This might be advisable in any case where even the slightest question arises

about a student's ability to carry on research to obtain a Ph.D. degree. The requirements for the MS degree in Biochemistry and Molecular Biophysics are successful completion of the three core courses and three optional courses (a minimum of 135 units; all of which are from 100+ numbered courses) and a GPA of at least 3.0. For more information, contact the Graduate Office.

In a more positive vein, it needs to be emphasized that the primary function of the Thesis Advisory Committee is constructive guidance toward the timely completion of the Ph.D. program, to supplement the guidance provided by a student's faculty supervisor. For this purpose, you should meet with your Thesis Advisory Committee sometime during your fourth year for an interim review of your progress.

During your fifth year, there should ideally be a meeting with the Thesis Advisory Committee at approximately the time that the experimental work for the thesis is completed and you are ready to actually write the thesis. This is an especially important meeting, at which the committee members should satisfy themselves that the research results, when presented in detail, are likely to produce an acceptable thesis. The plan for the organization of the written thesis should also be approved. If the end of the fifth year is approaching, and it appears likely that continuation of study and research beyond the fifth year will be necessary, the meeting with the Thesis Advisory Committee must result in the preparation of a specific plan, approved by the committee, outlining what needs to be done to complete the thesis and when it should be expected to be done. This plan must be submitted to the Option Representative along with the petition form requesting permission to register beyond the fifth year.

In any cases where extension beyond the sixth year is anticipated, each request for extension must again be based on approval by the Thesis Advisory Committee for a specific plan for completion of the Ph.D. In these cases, the committee should also consider whether financial support for the student should be continued, and make a recommendation to the Option Representative.

Students can request meetings with their Thesis Advisory Committee at other times, if particular problems arise. In addition, the student's faculty supervisor, or the Option Representative, can request that meetings be held if there are indications that more frequent monitoring would be valuable. This might include students who perform passably but not strongly on the qualifying examination, students who have been on leave of absence, and/or students whose work is erratic, perhaps indicating personal or motivational problems. However, such problems should be identified and resolved before admission to candidacy. The student's faculty advisor during the years before admission to candidacy has a particular responsibility to alert the student to any such problems at the earliest possible stage.

Completing the Ph.D.

Requirements for the Ph.D. thesis and examination are determined by the Ph.D. examination committee that is appointed by the Dean of Graduate Study for each degree candidate. This committee is usually the same as the Thesis Advisory Committee, but this is not essential. The composition of the committee must be approved by the Option Representative. The committee usually has at least four members who are Institute faculty.

The Ph.D. Thesis

The thesis is expected to demonstrate that the student has learned how to conceive, plan, and execute experimental and/or theoretical work that reveals new biological information. In addition, it must reveal a deep, broad, and rigorous understanding of the area of research to which the thesis is relevant. Development of new methods may be a major part of the work, but the successful use of these methods to attack important biochemical problems must also be accomplished.

The thesis is normally expected to contain work that should and will be published in appropriate research journals. However, there is no absolute rule requiring publication, and in rare cases a thesis committee may accept work that probably will not be published. An example of such a case would be that of a student whose work is "scooped" by progress in another laboratory, but where the work would otherwise be considered to constitute a solid thesis demonstrating the student's ability to carry out research.

The recommended format for a thesis is to have individual chapters written up in a form consistent with standard practice for publication of research papers. These chapters may be photocopies or typescripts of papers that have already been published or prepared for publication. Supplementary materials may be added as appendices to these chapters, or may be written as additional chapters, as appropriate. However, the option of writing the thesis as an independent document is also available to the student with the approval of the thesis committee. Detailed instructions on thesis preparation and the required forms are available from the Graduate Office.

Regardless of the format chosen, the thesis must demonstrate the degree of knowledge of relevant work in the research field that is needed to place the research results in their proper context. This is normally accomplished by a scholarly introduction that reviews the research field more broadly than is appropriate for the introduction to a research paper, and by a concluding discussion chapter that assesses the results in relation to other past, present, and future work in the field.

In cases where all or part of the work submitted for the thesis has been carried out in collaboration with others, the thesis must contain explanatory notes detailing the individual contributions of the student and the student's collaborators. In cases where some of a student's work forms a minor part of collaborative work, publications resulting from that work may be added to the thesis as appendices, or the student's contributions may be written up separately for

inclusion in chapters of the thesis. However, the thesis is expected to be a thesis, with a unifying theme or themes, and not just an aggregation of unrelated pieces of research.

The Final Ph.D. Examination

All Ph.D. candidates must present their work in a thesis seminar, usually held immediately before the final Ph.D. examination.

Please note: At the time of submission for approval to the Option Representative, a hard copy of the written thesis must accompany the *Petition for PhD Examination*. No exceptions will be made.

The purposes of the final Ph.D. examination are:

- (1) To expose any residual weaknesses in the thesis and arrange for thesis corrections. In the Biochemistry and Molecular Biophysics Option, we expect that students will meet with and discuss their work with members of their Thesis Advisory Committee throughout the years before the final examination, and that this process will eliminate any serious concerns that the members of the Ph.D. examination committee might have with the thesis research.
- (2) To allow the committee members to certify that the work constituting the thesis is quantitatively sufficient for the Ph.D. degree. Again, the basis for this determination will probably have been established by earlier discussions between the candidate and the members of the committee. It is difficult to specify universally useful standards for the quantity of work required for the Ph.D. However, it would probably be generally agreed that work that would not be sufficient for at least one substantial paper in a major research journal is not sufficient for a thesis.
- (3) To provide the committee members with an opportunity to satisfy themselves that the work presented in the thesis is actually the work of the candidate.
- (4) To assess, through oral examination following the thesis seminar, the breadth and depth of knowledge of the candidate relating to his/her field of interest.

The examination is considered to be passed when four or more members of the committee approve the thesis and the candidate's performance in the examination.

Other Policies, Resources, and Activities

There are both regular and irregular seminar series. Thursdays at 4:00 PM are reserved for Biochemistry and Molecular Biophysics seminars (147 Noyes). Mondays at 4:00 pm are usually reserved for Molecular, Cellular, and Developmental Biology and Inorganic Electrochemistry seminars. Tuesdays at 4:00 pm are usually reserved for General Biology seminars, Student's Biology seminars (organized by graduate students), and Chemical Physics seminars (147 Noyes). Wednesdays at 4:00 pm are usually reserved for Neurobiology seminars (24 Beckman). Also on Wednesdays at 4:00 pm are Organic Chemistry seminars (147 Noyes). Biology seminars are announced via "Biomail" email (contact Stephanie Canada at canadas@caltech to be put on the Biomail e-mail list). Chemistry seminar announcements are posted on bulletin boards. Seminar notices also appear in the *Weekly Institute Calendar* distributed to all students.

"Neurolunch" is an informal weekly meeting of people interested in Neurobiology. On Wednesday of each week there is a presentation by a student, postdoc, faculty member, or outside visitor, on the speaker's own research or on recent journal articles of interest. Neurolunch is held in 03 Beckman Behavioral Biology building. Lunch begins at noon; presentations begin around 12:30 pm.

"BioLunch" (Bi25 1a,b,c) is a weekly seminar in Molecular, Cellular, and Developmental Biology, Immunology and Biochemistry. On Wednesday of each week, speakers from two laboratories discuss their research, either in their present lab, or for newly arrived postdocs, their thesis research. BioLunch is held at noon in Beckman Behavioral Biology, room 24. Participation in BioLunch is required of all students supported by the NIH Training Grant. In addition, all BMB and BI graduate students will be scheduled to speak at BioLunch during their second and fourth years. All notices regarding BioLunch are sent via Biomail.

"Neurodinner" is an evening event that starts with a take-out dinner and is followed by informal presentations of the research activities of the members of one particular research group. These meetings are held approximately bimonthly.

"Organometallics" are student-organized seminars in inorganic, organo-metallics, and bioinorganic chemistry. These are held Fridays at 4:00 pm in 151 Crellin.

Immunology joint group meets are held on the first and third Tuesdays of each month at 5:15 pm in Room 3, Beckman Behavioral Biology, and consist of two research presentations by members of laboratories interested in immunology.

Structural Biology joint group meetings are held once a month on the third Friday of each month and consist of one presentation by a member of a group interested in structural biology.

"New Student Orientation Seminars" are presentations by the faculty to the new graduate students in chemistry, biology and biochemistry. The Graduate Office in the Chemistry Division organizes these seminars. In addition, the Biology Division has an annual weekend seminar retreat usually held in October. For more information, contact the Biology Division office.

Travel grants

Attendance at other meetings is considered to be valuable educational experience and can be supported by travel grants when sufficient funds are available. It is usually only possible to provide partial support for attendance at meetings or special courses, with the remainder of the support provided by the student or by grant funds of the student's faculty supervisor. Travel funds for NIH trainees become available on July 1. You should plan ahead and request funds early in the year, before our budget is exhausted. Requests for travel support from any source of funds administered by the Option should be made well before your trip, in writing, with an estimated budget, a statement of justification, and a supporting statement from your faculty supervisor. These requests should be submitted to the Option Representative.

Teaching

Graduate teaching assistantships (GTAs) provide useful assistance in our instructional program, provide a significant source of funding for graduate students, and often provide valuable teaching experience. All students are expected to serve as GTAs for one quarter a year through their fourth year of residence. If you are finishing your Ph.D. before the end of your fourth year, we will adjust this requirement to make certain that teaching during your final year does not delay completion of your Ph.D. Please discuss this with the Option Representative when the situation arises.

Most incoming students will be assigned a GTA position in one of our introductory courses—Bi 1, Bi 8, Bi 10, Bi 12 or Ch 1, Ch 3, Ch 4—and will be expected to repeat this assignment during their second year. After that, the assignment to a particular course is usually based on its relevance to a student's major. These assignments are made by the Option Representative, usually during the summer, and if you have preferences for a GTA assignment to a particular course, you should indicate your preference to the Option Representative in June, or earlier.

Stipend checks

Although we have a standard stipend level for all students, the sources of support vary from Training Grants and other fellowships, to GTA and GRA funds. All checks are issued on the 1st of each month.

Vacations

The official policy for NIH trainees is stated specifically in their guidelines: "Trainees in academic institutions are not entitled to vacations as such. They are, however, entitled to the normal short student holidays observed by their training institutions. The time between a summer session and the fall semester is to be utilized as an active part of the training period." The interpretation is that all students, whether NIH trainees or not, are expected to demonstrate a full-time, year-round

commitment to their professional training. Vacation time is at the discretion of your faculty advisor.

Acknowledgments

Please remember to acknowledge the source of your financial support on all of your publications resulting from work during your graduate program. For NIH trainees, the suggested form is “*This work was supported in part by a National Research Service Award (T32GM07616) from the National Institute of General Medical Sciences.*” [GM07616 is our Cellular and Molecular Biology training grant; the Neurobiology training grant number is GM07737; the Bioorganic and Bioinorganic training grant number is GM08501.] Support from all fellowships is important to acknowledge. Contact the BMB Option coordinator if you do not have information pertaining to your funding source.

E-Mail Accounts

May be obtained in the Information Technology Services (ITS) Facility in Steele, room 214.

Biology and Chemistry Shop Facilities

The biology student shop in room 327 Beckman Behavioral has basic machine tools and electronics equipment and is intended for fabrication and minor repairs of specialized devices used in individual research projects. It supplements the Divisional Electronics, Machine, and Equipment Repair Shops, in which the staff will do work for researchers. To use the student shop, check with Mike Walsh (237 BBB, ext. 6825). The chemistry student shop is located in the sub-basement of Church (room 09). Contact Mike Roy, Guy Duremberg or Ray Garcia at x6057 to use the student shop, which is available for students during the week from 8:00 am -12:00 pm and 1:00 pm - 4:30 pm. For more details about facilities, please see the attached lists for Biology and Chemistry or contact the facilities directly.

Stockrooms

The Chemistry stockrooms are located in room 157 Crellin and 139 Beckman Institute. The Biology stockrooms are located in 181 Alles and 127 Beckman Behavioral.

Mail boxes

Mail boxes will be assigned in the north end of the first floor of Braun (147-75CH) until a research lab is selected, in which case the mail box will be moved to the appropriate building.

Attachment #1

Guidelines for evaluating defense of the research proposition

The point of this exercise is to encourage the student, in collaboration with his/her adviser, to think through as deeply as possible the series of experiments that would form the basis of a thesis research project. The following criteria are suggested to provide the students with an indication of what is expected of them and to guide faculty in evaluating both the research proposal and the out of field proposal for the qualifying exam in the second year:

- * Has the student clearly defined the problem to be addressed?
- * Has the student clearly explained the significance of the problem?
- * Has the student become sufficiently familiar with the relevant field of research? Can he/she put the problem in context?
- * Are the experimental questions to be asked laid out in a logical manner? Is their rationale clearly presented? Are the experiments and their controls adequately described?
- * Has the student considered various possible outcomes of the experiments, and their interpretations?
- * Has the student considered contingencies in case the experiments do not work (or yield uninterpretable results)?
- * Based on his/her preliminary data, does the student have a feeling for the practicality of the experiments and their possible technical problems? (Relevant only to the research proposal).
- * Does the student have a rough timetable for the proposed project?
(Relevant only to the research proposal).
- * Is the out of field research proposal topic sufficiently outside the area of the student's thesis?

During the oral examination, the student can expect to be asked questions about general topics in biochemistry in addition to questions about the proposals.

The thesis advisory committee is encouraged to provide the student with constructive suggestions for the proposed project. In this way, the committee initiates an important ongoing role in helping to guide the student's research, not simply in evaluating the end product. However, the committee is also encouraged to base their evaluation as much as possible on the student's

ability to formulate a scientific problem and to pose it in experimental terms, and to avoid biases that reflect their value judgments about the proposed research.