UNIVERSITY OF PENNSYLVANIA
SCHOOL OF MEDICINE

GRADUATE PROGRAM IN
BIOCHEMISTRY AND
MOLECULAR BIOPHYSICS

2009-2010
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OVERVIEW

The central focus of the graduate program in Biochemistry and Molecular Biophysics (BMB) is the relationship between biological form and function at a fundamental level. This newly organized program provides students with an integrated and interdisciplinary approach to graduate education. The faculty in the BMB Graduate Group are unified by a common interest in understanding biological phenomena at the quantitative, mechanistic or molecular level, drawing on modern biochemical, biophysical, chemical and physical methods. The graduate program trains students in the scientific concepts and methods necessary for conducting basic research and its application to medicine. The program is designed to prepare students for careers as independent investigators.

The strength of the program resides in its unusually broad combination of faculty interests and disciplines. Faculty members are drawn from several departments within the Medical School (including Biochemistry and Biophysics, Physiology, Medicine, Pharmacology, Radiology, and Cell and Developmental Biology); from the Schools of Dental and Veterinary Medicine; from the School of Arts and Sciences (Biology, Chemistry, and Physics); and from affiliated research institutes such as the Wistar Institute and the Fox Chase Institute for Cancer Research.

Research areas of members of the BMB Graduate Group include

- Regulation of metabolism.
- Elucidation signaling mechanisms and pathways that result in physiological events, such as sensory transduction, cell division, death and control of the cell cycle.
- Determination of protein, RNA, DNA and virus structures.
- Protein and enzyme folding, function design and engineering.
- Regulation, transport and processing of RNA.
- Structure and function of membranes, including ion channels, gates, pumps and pores.
- Enzyme structure and function
- The mechanism of gene regulation, including transcription, replication, and recombination events, and generally the mechanism of protein recognition of specific sites on DNA.
- The molecular basis of immunology.
- Study of protein assemblies and the basis of specific protein-protein interactions.
- Molecular basis of energy transduction, including contractility, bioenergetics and photosynthesis.
- Development of novel high-resolution magnetic resonance and optical imaging methods.

Faculty in the Biochemistry and Molecular Biophysics Graduate Group typically use a combination of biochemical, biophysical, chemical and physical methods to unravel these complex biological events. These methods include:

- High resolution spectroscopies, including optical, infrared, fluorescence, phosphorescence, pump-probe spectroscopies
- X-ray diffraction
- Microscopy, including electron, optical and fluorescence microscopy
• Nuclear magnetic and electron paramagnetic spectroscopy.
• Optical and magnetic imaging.
• Theoretical methods and computer simulations.
• Quantitative kinetic measurements using radiolabels, hydrogen exchange, stop flow and other methods.
• Electrophoretic methods such as electrophoresis, conductance measurements and patch clamping
• Peptide, nucleic acid and organic synthesis methods.
• Thermodynamic analysis using calorimetry and temperature and chemical denaturation.
• Molecular biology techniques such as cloning and high level expression of proteins

Biochemistry and biophysics is a rapidly developing area of biomedical sciences. New techniques, methodologies, and information continue to evolve at an ever-increasing pace. The graduate program in Biochemistry and Molecular Biophysics is designed to produce the next generation of scientists who will advance the frontiers of biological and medical science

ADMISSIONS

Admission for Ph.D. study is offered to students with good undergraduate training in biochemistry, physics, organic chemistry, physical chemistry, biology, and mathematics. Students lacking preparation in a particular field, but otherwise qualified, may be admitted and given the opportunity to strengthen their backgrounds by taking the appropriate courses. The Graduate Record Examination (GRE) General Test is required; GRE Subject tests in biology, biochemistry, chemistry, physics or mathematics are recommended but not required. The Admissions Committee screens completed applications and decisions on admissions are based on undergraduate record, including research experience, GRE scores, letters of recommendation, and personal interviews. TOEFL scores are required for foreign students whose native language is not English. The deadline for applications for entrance in the following fall term is December 15th for US applicants and December 1 for non-US applicants. The BMB program especially encourages applications from minority students. Admission decisions are usually completed by late March. On-line applications can be accessed at http://www.med.upenn.edu/bgs/applicants_phd.shtml

Additional information can be obtained from the BMB Graduate Group office.

Students accepted for admission into the Ph.D. program receive tuition, and health care and insurance reimbursement, plus a twelve-month competitive stipend for living expenses. Awards are renewed annually for students in good academic standing. Support for graduate students comes from a variety of sources, including Biomedical Graduate Studies, training grants, faculty research grants, and from private foundations such as the Howard Hughes Medical Institute. Applicants are urged to apply for scholarships from the National Science Foundation and other graduate student funding programs. A limited number of fellowships are available for outstanding foreign students.
PROGRAM REQUIREMENTS

Overview

The Biochemistry and Molecular Biophysics graduate program is designed to prepare students for careers as independent investigators and educators in the area of modern biochemistry and molecular biophysics. The curriculum has been designed to provide a superior graduate level education by tailoring the curriculum to each individual student in order to round out the student’s knowledge of biochemistry and molecular biophysics, while building on the strengths of the student and equipping the student for dissertation research. In addition to formal lecture courses, research seminars and informal interactions with other graduate students, post-doctoral fellows and faculty members form an important part of graduate education. The ability to make oral scientific presentations is an essential part of a scientific training, and is a required part of the program.

General Requirements

- Three semesters of Laboratory Rotations (BMB 699) are required and are usually taken one per semester in the fall, spring and summer of the first year. The first rotation may be carried out in the summer before the first year if a student chooses to matriculate early.
- BIOM 600 (Cell Biology) - required.
- BMB 508 (Macromolecular Biophysics I) – required (fall, first year)
- BMB 509 (Macromolecular Biophysics II) - required (spring semester, first year)
- BMB 650 (Current Biochemical Topics: Raiziss Biochemical Rounds) - required; one additional credit may be taken as an elective.
- Eight additional elective credits are required that may include formal lecture courses and seminars.
- BMB 705 (Prelim Exam Preparation) – required (spring, second year)

Combined Degree Programs

Students in the MD/PhD program typically follow these guidelines for the Ph.D. portion of their coursework:

| Year 1 Medical School (spring) | One graduate course |
| Year 1 Medical School (summer) | One laboratory rotation |
| Year 2 Medical School (fall)   | One graduate course or one laboratory rotation |
| Year 3 (fall & spring)        | Full time graduate program and Prelim Exam |
| Years 4 - 6                   | Dissertation |
Eleven to fourteen credits may be transferred from the School of Medicine to complete the 8 elective credits that are required. MD/PhD students are usually exempt from Lab Rotation. Students are advised by the Academic Review Committee of the BMB Graduate Group and register through the BMB Graduate Group Office in years 1 – 3.

**Current BMB Courses**

**One-semester courses** (1 credit each)
- BMB 508 Macromolecular Biophysics I
- BMB 509 Macromolecular Biophysics II
- BMB 518 Protein Conformation Diseases
- BMB 550 Molecular Mechanisms of Signal Transduction and Control
- BMB 554 Macromolecular Crystallography: Methods and Applications
- BMB 560 Methods of Scientific Inquiry in Biological Systems
- BMB 567 Bioinorganic Chemistry
- BMB 571 Seminar Course
- BMB 581 Techniques of Magnetic Resonance Imaging
- BMB 585 Wistar Institute Cancer Biology Course: Cell Cycle Checkpoints and Cancer
- BMB 590 Biological Physics
- BMB 601 Fundamentals of Magnetic Resonance
- BMB 603 Advanced Topics in Magnetic Resonance
- BMB 616 Metabolic Pathways: Clinical Aspects of Energy Metabolism
- BMB 650 Current Biochemical Topics
- BMB 700 Selected Topics in Chemistry

**Mini-courses** (1/2 semester; 1/2 credit each)
- BMB 611 Advanced X-ray Diffraction Methods
- BMB 614 Membrane Biochemistry
- BMB 618 Applications of High Resolution NMR Spectroscopy to Problems in Structural Biology
- BMB 619 Protein Folding
- BMB 622 Physical Principles of Mechano-Enzymes
- BMB 624 Ion Channels and Pumps
- BMB 625 Optical Methods in Cell Physiology
- BMB 626 Mass Spectrometry and Proteomics
- BMB 627 Computing Programming for Biophysicists and Biochemists
- BMB 628 Principles of Scientific Instrumentation
- BMB 629 Quantitative Problems in Biochemistry and Biophysics
- BMB 630 Imaging
- BMB 631 Redox Potential, Electron Transfer
- BMB 632 RNA
- BMB 633 Seminar on Selected Topics

**Other courses**
- BMB 598 Tutorial (1 credit)
- BMB 699 Lab Rotation (1 credit)
BMB 705 Prelim Exam Preparation (1/2 credit)
BMB 799 Independent Study (YRS 1 – 2) (may be taken for 1/2 to 4 credits)
BMB 999 Independent Study (YRS 3 – 5) (may be taken for 1/2 to 4 credits)

It is expected that in the first year, courses of a more general and foundational nature will be taken in order to give students a well-rounded and diverse background in the biochemical sciences. Subsequent lecture or seminar courses are designed to increase the student's background in more specialized areas. The three laboratory rotations ensure that first year students quickly become familiar with the variety of research opportunities available within the graduate program and so can choose a suitable Thesis Advisor. Full-time thesis research generally begins at the end of the second year, and students are encouraged to develop rigorous and creative approaches to examine significant problems in biology.

Many of the courses available to BMB students are taught in collaboration with other graduate programs or departments. Topics covered by these courses include molecular genetics of prokaryotes and eukaryotes, the structure and function of proteins and nucleic acids, molecular cell biology, biophysics of macromolecules, regulation of cell growth, membrane structure and function, virology, gene therapy, X-ray diffraction, and spectroscopy. A listing of all courses offered at the University is described in the University’s Course Register or online at http://www.upenn.edu/registrar.

**Lab Rotation (BMB 699)**

1. The purpose of the Lab Rotation is to provide the student with the opportunity to experience different laboratory environments and different experimental approaches and in so doing, assist him or her in choosing a laboratory for thesis work.

2. A student is required to do a rotation in three different laboratories. The rotations must be with a member of the Graduate Group. The Chair of the Graduate Group must approve, in writing, any exemptions from the three required lab rotations.

3. In general, all rotations are to be completed by the end of the first year, enabling the student to select a research lab by the beginning of the second year.

**Time schedule for rotations:**

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Semester</th>
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<tbody>
<tr>
<td>Rotation 1</td>
<td>Fall semester</td>
</tr>
<tr>
<td>Rotation 2</td>
<td>Spring semester</td>
</tr>
<tr>
<td>Rotation 3</td>
<td>Summer I semester</td>
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</tbody>
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An incoming student may take Rotation 1 in the summer prior to the Fall semester. The date for the start of the Lab Rotation is different every year, but is usually the first or second week of June.

4. Students should begin to search for a Faculty Supervisor about one month before the beginning of the proposed rotation. An appointment to discuss possible projects should be arranged with the potential Faculty Supervisor. Students are encouraged to talk with several faculty, and to discuss with the Course Director the choice of Faculty Supervisor and other options, prior to making a commitment to a specific laboratory.
5. The rotation is under the supervision and guidance of the Faculty Supervisor. At the beginning of a lab rotation, the Faculty Supervisor and student are encouraged to discuss and clearly define the goals of the project. A "Lab Rotation Approval Form" with project title must be signed by both the student and the Faculty Supervisor, approved by the Course Director, and returned to the Academic Office. The Course Director should be notified in case of difficulties or shortcomings that may jeopardize the expeditious and satisfactory progression of the proposal.

6. Upon completion of the rotation, the Faculty Supervisor must submit a grade and a written evaluation of the student's performance for inclusion in the student's file. A copy of this evaluation may be given to the student upon request. Students are encouraged to discuss the contents of the written evaluation with their Faculty Supervisor. The student will also be asked to provide a confidential evaluation of the lab rotation experience.

7. One week prior to the rotation talks (see below), a 150-word abstract should be submitted to the course director and the Academic Office. The abstract should describe the issue/question motivating the study, the approaches taken to address the issue/question, and a synopsis of key findings, conclusions and future directions. Failure to submit the abstract in a timely manner will affect the rotation grade. Please also give your abstract a title (which does not count toward the word limit).

8. At the end of each semester (fall, spring and summer), all students participating in rotations that semester will be scheduled to present a short talk (10 – 12 min talk, 3- 5 min questions) on their work to the Graduate Group faculty and students (Lab Rotation Talks). The emphasis is not on the quality/quantity of the date acquired, but on (a) learning to give a talk (communicating) and (b) demonstrating how one has thought about one’s research project, including the overall aims, thrust and importance of the project. Students are welcome to choose whatever form(s) of visual aid they prefer, including overheads, slides and/or PowerPoint-type presentations. Given the ease and accessibility of PowerPoint, use of this medium is encouraged.

This is a requirement for completion of the course. The main purpose of the talk is to give the students at least three opportunities to present a prepared/practiced short talk in a relatively informal setting, and to provide them with helpful feedback pertaining both to the scientific content and to the student’s style and presentation skills. Anyone who fails to give a presentation at the scheduled time will obtain an incomplete for the course and will be scheduled to present on that rotation during the Lab Rotation Talks the following semester (giving two talks if also registered in the class for that semester). Under exceptional circumstances, and subject to approval by the Course Director and the Faculty Supervisor for the rotation, a paper may be accepted in lieu of the presentation. The Faculty Supervisor may also require a student to prepare a short report or paper at the completion of the rotation.

See Suggestions for Talk Preparation and Presentation (80 KB Word document)

9. Attendance at the Lab Rotation Talks is required. Unexcused absence from all or part of the session will result in reduction of the grade submitted by the Faculty Supervisor by one half grade.

10. After completing the three rotations, students should be able to make an informed choice as to a Thesis Advisor. If a student is not able to find a suitable lab after three rotations, he or she can petition the Course Director for permission to do an additional rotation or independent study to find a Thesis Advisor.
Tutorial (BMB 598)

The tutorial course is designed to provide students with an in-depth appreciation of a specific subject, and present their knowledge orally. One of the tutorials can be used to enable students to become more deeply acquainted with the literature related to their thesis project. The tutorial can also be used to better prepare students for their Candidacy Exam.

Upon completion of the tutorial, students must prepare a written description of the area studied (5-10 typewritten pages) and present a short seminar (15 to 20 minutes) on the specific topic. Students will be graded on both the written and oral presentations. Graduate Group faculty and students are invited to attend these talks.

Independent Study (BMB 799 and BMB 999)

Independent study can be taken for 1/2 to four credits per semester. In general, the time commitment for 1 course unit of independent study is approximately 16 weeks at 10 hours per week; in the summer (total course units are 2 course), 1 course unit is considered to be approximately 6 weeks at 20 hours per week. There is no Graduate Group requirement for Independent Study. The laboratory director may require a paper or presentation at the conclusion of the Independent Study.

ACADEMIC ADVISING

Students are advised at two levels. Each first and second year student meets with the Academic Review Committee at the beginning of fall and spring semester to plan his or her curriculum for the following semester. In view of the exceptional diversity of the trainees, the Academic Review Committee reviews the background of each student, and in consultation with the student, decides on the curriculum for that student. The goal is to provide a flexible yet structured program so students of diverse backgrounds will receive the appropriate training for their research interests.

Each incoming student is also assigned a faculty mentor. The role of the mentor is to provide informal advice on more general aspects of graduate education, such as adjustment to graduate life, guidance in career paths, and to advise a student in choosing a Thesis Advisor.

CANDIDACY EXAMINATION

All graduate students affiliated with BGS (Biomedical Graduate Studies) are required to pass a Candidacy Examination in the spring of their second year. The Examination consists of both a written and an oral presentation. Only students in good academic standing are eligible to take the Candidacy Examination.

Working Candidacy Examination Committee

A Candidacy Examinations Advisory Group, consisting of members from the BMB Graduate Group will be established and will have the ultimate responsibility for administering the
Candidacy Examination. At least one member of this Advisory Group will serve as chair of the student’s candidacy exam committee, which will consist of a total of three faculty members.

The student’s candidacy exam committee will be selected approximately six weeks prior to the oral exam. The students will choose the chair of their committee from the Advisory Group. Students will be asked to suggest faculty for inclusion on their candidacy exam committee; however, the final committee will be chosen by the chair. Students will be notified of their committee and may contest one member of the committee.

Purpose

The purpose of the written Candidacy Examination is to examine the ability of graduate students at the end of their first year to: 1) identify an important problem in biochemistry and biophysics; 2) review the literature; 3) formulate a testable hypothesis; and 4) write an NIH-style research proposal that tests the hypothesis. Although most proposals will be hypothesis driven, technology-driven proposals are also acceptable, if they clearly address a major need in biochemistry and biophysics. If a technology-driven proposal is selected, the proposal must clearly articulate the problem that a given piece of technology will address, and the proposal must clearly appraise competing technologies. The purpose of the oral Candidacy Examination is to examine the ability of students to: 1) defend the design and feasibility of the written proposal; 2) explain basic concepts in biochemistry; and 3) to explain both the theory behind and practical application of various biophysical techniques.

The Written Proposal

The student may choose a topic for the research proposal that is either thesis or non-thesis related. If a student chooses a topic related to his or her proposed thesis research, the proposal must be the original work of the student and should not deliberately duplicate any part of previous grant proposals written by the Thesis Advisor or other lab members. The purpose of the written proposal is for the student to independently consider and formulate research goals. As deemed appropriate by the advisor, students can read portions of their advisors grants as examples. However, in no case should portions of the advisor’s grant be reproduced or simply paraphrased in the student’s proposal. In preparation, the student should conduct a very thorough review of the literature relating to the proposal topic, and should also be familiar with the fundamental theory and practice of techniques that will be employed. Students are free to seek the advice of their Thesis Advisor, other graduate faculty, and students to help select a topic, formulate aims, and in providing input on early drafts of the entire proposal.

The proposal should provide a succinct account of the literature and a detailed experimental approach. The proposal should represent a logical series of experiments to provide a solution to the stated problem. It is required that students give a description of their predicted results, their quantitation and, if necessary, tables or graphs showing the anticipated data. The level of quantitation should match the level of the question being asked. It is recognized that certain experiments and/or techniques may fail. With this realization, students should describe in outline form only, alternative approaches.
The proposal (excluding references) should not exceed 10 typewritten pages and should have the
same structure as an NIH postdoctoral training grant. References are not included in the page
count. **Font Requirement follows that of the NIH:** NIH now requires the use of an Arial,
Helvetica, Palatino Linotype or Georgia typeface and a font size of 11 points or larger. (A
Symbol font may be used to insert Greek letters or special characters; the font size requirement
still applies. A smaller font size may be used for figures, graphs, diagrams, charts, tables, figure
legends, and footnotes, but this type must follow the font typeface requirement and be readily
legible.) The left and right margin should be set to 0.5 inch, and the top and bottom to 0.7 inch.
Proposals that exceed the page limit or use smaller fonts will be returned without review.

The written proposal will consist of the following. The number of pages indicated below are
suggestions, and can be modified somewhat as needed as long as the proposal (excluding
references) does not exceed the 10 page limit.

1. **Specific Aims:** state the specific purposes of the research proposal and the hypothesis to
be tested. (1 page) There should be two or more specific aims, and it is sometimes
convenient to break them sub-aims. Each aim should address a question or a hypothesis.
It is not appropriate to simply state what one wishes to do experimentally without a larger
context of what questions are being addressed.
2. **Background/Significance:** sketch briefly the background to the proposal. State
concisely the importance of the research described in your proposal by relating the
specific aims to broad, long-term objectives. Compare your approach to other
approaches or related studies in the literature, and explain why your study will advance
the field significantly beyond previous studies. (3 pages)
3. **Preliminary Results:** Presentation of preliminary results is not required. If the proposal
is directly related to the student’s thesis research, then preliminary results may be
reported, especially when those results will help to establish the feasibility of the
proposed experiments.
4. **An Outline of the Research Design and Methods:** the research design and procedures to
be used to accomplish the specific aims, a tentative sequence for the investigation, the
statistical procedures by which the data will be analyzed, and denote any procedures,
situations, or materials that may be hazardous to personnel and the precautions to be
exercised. Potential experimental difficulties should be discussed together with
alternative approaches that could be used to achieve the desired aims. (up to 6 pages)
5. **Literature Citations:** At the end of the research proposal. Each citation must include the
names of all authors, title of article, name of the book or journal, volume number, page
numbers, and year of publication. Citations do not contribute towards the page count.
6. **Figures:** Figures should be included that contribute to the explanation of the background
material, that assist in describing novel experimental techniques, and that depict typical
expected results and how those results will be analyzed. All figures should include a
legend that explains the contents of the figure and cites published sources; the legends
should be placed with each figure and not on a separate page. Figures should be spliced
into the text.

A rough draft of the specific aims for the proposal should be turned in to the members of the committee approximately five weeks prior to the exam. The members should approve a final
title and specific aims four weeks prior to the exam. If the committee members fail to contact
the student, the student can assume that the proposed aims meet the approval of the committee members. If committee members wish for changes to the aims, they should work with the student directly. After the faculty members approve of the proposal they should not help the students with the proposal (except to answer general questions or suggest literature). The completed proposal must be in the hands of the committee one to two weeks prior to the scheduled exam date (but in no case less than a full week prior to the exam).

**Defense of the Proposal**

The student will begin the Candidacy Examination by presenting an approximately 15-minute synopsis of the proposal consisting of not more than eight prepared slides or transparencies. The presentation should emphasize the specific experiments proposed in the written proposal. The faculty may interrupt to ask clarification of specific points, but the questions and answers should be brief to allow the student to complete the presentation within about a half hour. *Committee chairs and the students themselves should be cognizant of the need to keep questions to a minimum until completion of the student’s oral presentation.*

Following the presentation, the committee members will ask questions. The student should field these questions verbally, using a chalkboard or whiteboard to write equations, reactions, or pathways as necessary. The student may refer back to one of the prepared slides, and may refer to any figure in the written proposal, but may not introduce new slides or figures at this point. In defending the proposal the student should show an in-depth knowledge of biochemistry and biophysics. Since the Graduate Group offers a Ph.D. degree in biochemistry and biophysics, a thorough knowledge of the fundamentals of these disciplines is expected. For example, if the proposal contains molecular biological approaches, then the student should understand the biochemistry of DNA polymerases. If a binding assay is used, the student should understand the thermodynamic and quantitative background to binding (including basic concepts such as changes in enthalpy, entropy, heat capacity, etc.). If a biophysical technique such as NMR is used, the student should be familiar with physical principles underlying the technique and what the technique can and cannot measure. Students are reminded that biochemical and biophysical phenomena are often explained by consideration of rate-theory, thermodynamic considerations, ligand affinities, and kinetic constants, and questions on these topics are generally quite appropriate. Furthermore, students should demonstrate an understanding of the amounts (mnoles, micrograms etc.) and concentrations (micromolar, nano-molar) of biochemicals they need to perform their experiments and an understanding of the magnitude of the changes they will be measuring.

While no topic is off-limits, overly technical questions in an unrelated subspecialty may be unreasonable. For example, a student studying transcriptional regulation would not be expected to understand technical aspects of making spin relaxation measurements by NMR, unless the research proposal incorporates this technique.

Students should also be prepared to discuss in detail literature in their fields describing past work and alternate methods or approaches to solving their biochemical problem.
Pass/Fail Procedures

After the oral examination, the committee will meet without the student present to discuss the student's performance. The committee will decide whether the student has passed or failed and will unofficially inform the student of its decision immediately. The student’s committee chair will write a summary of the discussion. All members will write a review of the oral and written content of the proposal. The critiques should be electronically sent to the chair of the student’s committee within one day of the presentation. These reviews and the chair’s summary should be communicated to the student within two days, and will remain in the student’s permanent file.

Pass with distinction: If the student passes, the Director will notify the Graduate Group Chair immediately. In addition, the Academic Review Committee will assess the student's progress and ensure that the student is in good academic standing and that the 20 non-dissertation credit requirement has been satisfied. A student will receive written confirmation of passage of the Candidacy Examination from the Graduate Group Chair and the written critiques from the committee, and will begin on dissertation status.

Provisional pass: The student may pass, but only after addressing one or more problems identified by the student’s prelim committee. These items might be associated with the written proposal, a problem with the presentation, or a lack of background knowledge. The committee chair will outline a course of action to address the issue (which might not require reconvening the committee) and the student will have a week to address the concerns. It is expected that the concerns will be addressed, in which case the provisional pass will convert to a pass. If for some reason the concerns are not addressed within this time frame, a provisional pass will convert into a first fail.

Fail: If a student fails the first attempt at the Candidacy Examination, the committee will recommend revising the proposal and repeating the entire oral exam. For the second attempt, an additional member of the graduate group’s Prelim Advisory Committee will be added to the student’s committee. The student will have four weeks to rewrite the proposal and/or prepare for the second oral exam. In addition, the chair of the student’s committee will solicit a letter of support from the proposed Thesis Advisor and will obtain a copy of the student’s academic file to assist in reaching a final pass/fail decision. The chair of the student’s prelim committee will notify the Graduate Group Chair, the chair of the graduate group’s Prelim Advisory Committee, and Academic Review Committee the outcome of the examination. If the student fails the second exam, the Graduate Group Chair and Academic Review Committee are ultimately responsible for reaching a final decision regarding whether the student should leave the graduate program. In the case where termination is deemed necessary, the student may, if all other requirements have been met, be eligible for a terminal Master of Science degree.

Candidacy Examination Preparation Course
This half semester course instructs second year BMB graduate students in the proper structure of an NIH-style grant proposal. The students will read and critique sample grant proposals and begin formulating and writing their specific aims. This course will meet 1.5 hours per week, is worth 1/2 credit, and is graded. Grades will be based on attendance, discussions, and presentations.
**Dissertation Status**

Students are expected to carry out their thesis work under the supervision of a faculty member of the Biochemistry and Molecular Biophysics Graduate Group. After passing the candidacy exam, students must form a Working Thesis Committee and schedule a Committee meeting by the end of the first semester of the third year. The Graduate Group Chair must approve exceptions to these rules.

**Composition of Thesis Committee**

The Working Thesis Committee will be comprised of four faculty, at least three of who must be members of the BMB Graduate Group. The Thesis Committee Chair must be a member of the BMB Graduate Group. For the final thesis defense, a full examination committee of six members is required, at least four of who must be members of the BMB Graduate Group. It is highly recommended that an external examiner (i.e. someone from outside the university, with expertise in the area of the thesis work) be brought in as an additional examiner for the final thesis defense. The thesis committee should be constituted to include breadth as well as expertise in the particular research area of thesis work. The student and his or her advisor shall jointly select the members of the thesis committees. The student should submit in writing a list of potential committee members, indicating which faculty will serve as committee chair, to his or her Thesis Advisor and the Graduate Group Chair. The Graduate Group Chair will respond in writing to approve the composition of the committee, or make recommendations for other candidates. The Graduate Group Chair will adjudicate any disagreement on the composition of the thesis committee. The Thesis Advisor may not serve on the committee or vote on the thesis defense, but may attend committee meetings and the thesis defense, but may not participate in the deliberations of the committee.

The student must register the composition of his or her thesis committees with the Graduate Group Office after approval by the Graduate Group Chair.

**Evaluation of Student’s Progress**

The Working Thesis Committee must meet every 6 months or as determined by the Committee, to monitor the student’s progress. The Thesis Committee is permitted and indeed encouraged to interview the student in the absence of the Thesis Advisor and vice versa. A written summary will be prepared after each meeting by the thesis committee chair and will be placed in the student’s academic file. Upon written approval by the Chair of the Thesis Committee, the 6-month requirement may be waived, and yearly meetings held instead.

If the Committee and/or the Thesis Advisor are not satisfied with the student's productivity, a written report will be prepared by the Committee outlining a proposed course of action. A copy of the report will be forwarded to the Graduate Group Chair, the student and the Thesis Advisor. The student will have the opportunity to reply to the written report of the Committee. Within 6 months, an additional meeting of the Thesis Committee will take place to determine the progress. In the event that the student does not make sufficient progress, he or she will be placed
on academic probation. If progress is not apparent by the next Committee meeting, the student will be asked to petition for a terminal Master’s degree.

**Preparation of Dissertation**

The thesis committee will give written approval for the student to begin to write the dissertation, but this does not automatically mean that experimental work is completed. The student should be prepared to continue experiments while writing and to rewrite or do additional experiments after the thesis defense if deemed necessary by the committee. If the student has not already done so, at this point he or she should, in conjunction with the Thesis Advisor, select the remaining two members of the committee to form the full examination committee. A draft of the dissertation must be submitted at least two weeks in advance of the defense to minimize the possibility of unexpected problems. The Graduate School of Arts and Sciences (GAS) requires a dissertation to represent a definite contribution to scientific knowledge and to show that a student possesses "power of independent research." The Graduate Group feels that the dissertation should contain experimental information that answers a stated question and should display a logical progression of scientific thought. The main information contained in the dissertation should be of a caliber sufficient for publication in a reputable refereed scientific journal.

**Thesis Seminar and Defense**

The thesis seminar will take the form of a public lecture. The private portion of the defense may be conducted solely by members of the Thesis Committee and the Graduate Group Chair and in the absence of the Thesis Advisor. The decision on approval of the thesis will be made solely by a consensus of the thesis committee in the absence of the student and the Thesis Advisor. Students who are defending their theses must inform the Graduate Group Office at least two weeks in advance of the defense date, and supply the title of the thesis and place and time of the defense, as well as an abstract. The Graduate Group Office will announce the thesis defense to the University community. The Graduate Group Office is responsible for completing the forms indicating that the thesis has been successfully defended. Before a student makes the appointment to deposit the thesis, he or she must provide the Graduate Group Office with a copy of the abstract page, a signed copy of the title page, and postdoctoral appointment information.

**STUDENT ACTIVITIES**

**Faculty Research Talks**

All first year students are required to attend Faculty Research Talks held the first week of September and the last week of December, at which Graduate Group faculty present mini-talks related to lab rotation projects that they can offer to first year students.

**Seminars, Faculty-Student Tea, Science Club**

Students are expected to participate in the activities of the Graduate Group that are intended to enhance the research environment at Penn. Seminars include the Dr. George W. Raiziss Biochemical Rounds sponsored by the Department of Biochemistry and Biophysics (Fall
semester), the informal Friday Research Discussions (Fridays at 4:00 p.m.), and the Department of Biochemistry and Biophysics Seminars (Spring semester, Thursdays at 12:00 noon). Students are encouraged to participate in the selection of speakers for these programs.

Retreat

The BMB Graduate Group and the Department of Biochemistry and Biophysics sponsor an annual two-day retreat at Swarthmore College at the end of June. The retreat features talks by faculty, students and postdoctoral fellows, and three poster sessions. Students are encouraged to present their work via talks or poster presentations. A picnic and the annual softball game between the graduate students and the faculty culminate the two-day event.

OTHER PROGRAM INFORMATION

Academic Standards

The University standard for satisfactory academic progress is a 3.0 grade point average (B). The minimum standard for final course grades in the BMB Graduate Group is a "B". A BMB student who does not achieve the minimum grade for courses will be referred to the Biomedical Graduate Studies Academic Standards Committee. The Academic Standards Committee will, in concert with the BMB Academic Review Committee's recommendations, impose sanctions such as academic probation. In addition, the Academic Review Committee may ask a student to retake a course, continue course work towards the terminal Master's Degree, or withdraw from the program. The Academic Review Committee will review each case on an individual basis.

Transfer of Credit

Students who enter the program having taken similar courses at the graduate level at other institutions may petition the Graduate Group for transfer of credits. The decision to approve transfer of credits will be made in writing by the Graduate Group Chair. Up to eight courses may be transferred. Students who have taken graduate courses at Penn through the College of General Studies (CGS) may apply to transfer up to four course units toward the Ph.D. degree. Combined degree students may transfer as many as 14 course units from another Penn professional or graduate program, but are required to take 8 course units of Ph.D. lecture courses and seminars. It is recommended that students review any courses that may be transferable with the Academic Review Committee when first entering the program.

Transfer from Other Programs

University of Pennsylvania students who are currently enrolled in another graduate group within BGS may be considered for transferring into the BMB Graduate Group. Students should express their interest in joining the BMB Graduate Group by writing a letter of intent to the Graduate Group Chair. The student will then meet with the Chair to review his or her academic record and establish a plan for meeting the BMB requirements. Students who wish to transfer
from graduate groups outside of BGS need to follow the same procedures as regular applicants to the program.

**Terminal Master's Degree**

Students are not admitted to the Graduate Group for study towards a Master's degree. However, the Graduate Group may award a terminal Master's degree to students who choose not to continue in the Ph.D. program. In certain instances, the Graduate Group Chair may recommend that students who have not performed satisfactorily in course work, the Candidacy Examination, or dissertation research leave the program with a terminal Master's degree. The University requires a minimum of 8 course units for the terminal Master's degree. A final paper or master’s thesis may also be required, as determined by the Graduate Group Chair and Academic Review Committee.