



ACADEMIC PROGRAM GUIDELINES

Program in Biochemistry

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Biochemistry Ph.D. Program Washington University in St. Louis

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Overview

Washington University has a century-long tradition of excellence in biochemistry research and education. A number of faculty, students and fellows associated with the university have been awarded the Nobel Prizes for research in biochemistry and closely related fields. These include Edward Doisy (1943), Carl and Gerty Cori (1948), Arthur Kornberg (1959), Severo Ochoa (1959), Alfred Hershey (1969), Earl Sutherland (1971), Daniel Nathans (1978), Paul Berg (1980) and Edwin Krebs (1992). Currently, the School of Medicine ranks third in the nation in the amount of research funding received from the National Institutes of Health. Washington University pioneered inter-departmental graduate education by establishing the Division of Biology and Biomedical Sciences in 1973. The Biochemistry Ph.D. Program now involves 67 faculty members from 14 departments in the School of Medicine and the School of Arts and Sciences.

Biochemistry Ph.D. Program Guidelines

Research in biochemistry utilizes the concepts and approaches of chemistry to understand the molecular basis of biological processes. Fundamental chemical principles and techniques are used to understand the stability and specificity of macromolecular interactions as well as their mechanisms of action in processes such as DNA replication, signal transduction and gene regulation. The complexity of the biology makes the application of chemical principles challenging for the biochemist. The focus of much biochemical research is on the molecular description of biological processes. Receptor-ligand interactions, macromolecular stability and assembly, enzyme catalysis and ion channel activity are of particular interest, since these are central to the function and regulation of biological systems. Studies of the kinetics and energetics of molecular interactions and the structure and dynamics of the macromolecules involved provide the main experimental avenues to obtain a molecular description of biological processes.

The main goal of the Biochemistry Ph.D. Program is to equip students with the knowledge and skills required to be an effective research scientist, including (i) the ability to propose, discuss and critically evaluate ideas, (ii) the mastery of fundamental information and concepts in biochemistry and closely allied fields, (iii) the ability to conceive hypotheses and design experiments to test these hypotheses, (iv) the technical skill to conduct and analyze experiments, and (v) the ability to communicate scientific findings in an effective manner, both in written and oral form.

Graduate training is formally divided into two stages: pre-candidacy and candidacy. Students usually complete the requirements for candidacy by the end of the second year (or first graduate year for MSTP students). The requirements for candidacy include coursework, 3 laboratory rotations, a one-semester teaching assistantship, and the preliminary exam. Once the student becomes a candidate for the Ph.D. degree, training consists of directed thesis research under a mentor of the student's choosing with guidance from a thesis committee. Students are encouraged to complete and defend their Ph.D. dissertations by the end of the fifth year.

Course Requirements

Chemistry and Physics of Biological Molecules; BIO 5357 (Taken in Fall of 1st year)
Biochemistry Student Seminar; Bio 5466 (Offered twice each month in Fall and Spring semesters)
Advanced electives: Two from approved course list below, or other appropriate courses, subject to approval by Program Director.
Journal clubs (3 credits, taken after year 1)
Ethics and Research Science; Bio 5011 (Taken in the spring of 2nd year)

Approved course list for advanced electives:

Organic Chemistry III; Chem 451 (Offered in Fall)
Modern Medicinal Chemistry; Chem 477 (Offered in Spring)
Nucleic Acids and Protein Synthesis; Bio 548 (Offered in Fall)
Molecular Cell Biology; Bio 5068 (Offered in Fall)
Immunobiology I; Bio 5053 (Offered in Fall)
Macromolecular Interactions; Bio 5312 (Offered in Spring)
Cellular Neurobiology; Bio 5571 (Offered in Fall)
Molecular Microbiology & Pathogenesis, Bio 5392 (Offered in the Spring)

Biochemistry Ph.D. Program Guidelines

For the first semester of the first year, Biochemistry students take two courses plus a laboratory research rotation.

The advanced elective can be any 400 level or above course offered through Arts & Sciences upon consultation with the Biochemistry Steering Committee at advising.

Because of overlap with the medical school curriculum, MSTP students in the Biochemistry Program may take Bio 5357 or 5068 during the first medical school year in place of Molecular Foundations of Medicine. This option reduces the number of graduate courses that MSTP students take during the first graduate school year.

During the course of graduate studies, students take five credits of special topics courses, tutorials, or journal clubs. Two of these credits will be earned in the Graduate Student Seminar course. The purpose of this requirement is three-fold: (i) to provide close student-faculty interactions in a format that is less didactic than standard courses; (ii) to allow students to study current research topics in greater depth; and (iii) to provide students with a mechanism to learn the skills of public speaking and seminar presentation. Thus, a large component of these courses involves coaching in oral presentation.

For journal clubs, a student will receive one credit for regular participation and for giving one presentation. A journal club must be on the University Course Listings.

A grade of B- or better in each course, with an overall GPA of at least 3.0, is one of the requirements to achieve candidacy, and a GPA of 3.0 must be maintained in order to remain in good academic standing.

Advising

Timely and good advice can be very important to graduate students. Students in the Biochemistry Program should take advantage of advice from a number of sources, both informally from faculty and students and more formally from appointed advisors that meet with the student at appropriate intervals.

Faculty Advisors: The Biochemistry Steering Committee advises students until the thesis proposal is approved. Each student will meet with members of the committee just prior to the beginning of each semester to discuss options and to register for courses. To register, drop or add courses, students must obtain the signature of a steering committee member. In addition, each student is assigned an individual faculty advisor. The advisor is available to help students plan laboratory rotations and select courses. Once a student has completed a thesis proposal, the thesis committee assumes responsibility for advising. However, students may continue to consult with their previous advisors as they see fit.

Student Mentors: The upper-level students may act as mentor and serve as a first source for answers to many questions but also may encourage the student to meet with a faculty advisor when appropriate.

Biochemistry Ph.D. Program Guidelines

Laboratory Research Rotations

At the beginning of the first semester, students plan laboratory rotations with the help of their advisors. In general, students complete three laboratory rotations, each typically three months long, by the end of their first year in the program. At that time, they select a thesis mentor and join that laboratory for the duration of their graduate training. Students are urged to discuss possible rotation projects with their advisors before making their selections. (Students are prohibited from conducting rotations in laboratories where they have been previously employed. However, previous employment would not prevent the student from pursuing thesis work in such a laboratory.) The student should develop an outline of the proposed work with the faculty member. The Division Office provides students with a Rotation Form for this purpose. The form should be completed by the student with the rotation mentor's help and returned to the Coordinator at the start of each rotation. A second part of the form is completed at the end of the rotation to provide the Steering Committee with an evaluation of the rotation experience.

The purpose of the laboratory rotations is to broaden the student's research experience and to expose them to available opportunities before a thesis preceptor is selected. *It should be recognized by both student and rotation mentor that significant research accomplishment is not a requirement for a successful rotation, nor should the rotation be prolonged significantly beyond the normal three-to-four month period to meet particular research objectives.* Students may choose to end a rotation early if necessary or desirable, but only after discussion with the rotation mentor and faculty advisor.

During the rotation, the student should take advantage of the one-on-one relationship with the faculty member to discuss science as it is carried out in the lab and to evaluate together the approach to research. Students should explore these contacts carefully during rotations, mindful that selection of a good mentor who will provide the personal instruction required to master experimental science is the most important decision they will make in graduate school.

Teaching Requirement

Effective communication of information and concepts is a critical skill for biomedical research scientists. While much of the teaching that scientists engage in is through one-on-one interactions with individuals in the laboratory, all scientists must be able to deliver lectures to a wide audience (from peers in the field to neophytes with a limited understanding of the nuances of the topic), and scientists in faculty positions will often teach courses to undergraduate and graduate students. Therefore, DBBS students must demonstrate the ability to effectively communicate complex ideas and concepts to groups of individuals at various levels of understanding. To develop these critical communication skills, DBBS students will:

- Complete the TA orientation and three approved workshops offered by the Teaching Center by the end of the 2nd year of graduate studies
- Serve as a Teaching Assistant in a DBBS-approved graduate or undergraduate course for 1 or 2 semesters. The TA assignment will include giving lectures and/or leading lab sessions. The TA is usually completed in the 2nd year of graduate studies.
- Deliver a minimum of four oral presentations at journal clubs, seminars, scientific conferences, and retreats. Presentations given as part of a TA assignment, lab meetings or thesis committee meetings will not satisfy this requirement.

Biochemistry Ph.D. Program Guidelines

Qualifying Examination

The purpose of the qualifying examination is twofold. First, the examination will determine if the student has acquired sufficient knowledge and ability to think critically to qualify for candidacy. Second, the exam will provide the student with an opportunity to practice preparing a research proposal.

The comprehensive exam will consist of two sections:

- 1) Defense of the research proposal and
- 2) examination of general knowledge based on the students course work.

The Format of the Written Qualifying Examination:

The qualifying examination consists of a written research proposal focused on a biochemistry project. This project can either be outside or within the student's general area of research interest. However, it cannot be their developing thesis project or other projects investigated in the laboratory of their thesis mentor. Students can propose to use methodologies that are being used in their thesis lab if these are the most appropriate methodologies to investigate the prelim topic. Methodologies should be largely quantitative in nature.

The proposal should involve hypothesis-driven research; i.e., posing and testing specific questions about a scientific problem. The proposal should be creative and unique, and not a simple extension of an ongoing project in the lab. Students can consult Steering Committee Members in the selection of their topic. The Steering committee will approve the outline of the proposal, presented as the "Specific Aims" page, or suggest changes.

The proposal shall take the general format of a predoctoral NIH F30/F31 application, <https://www.nigms.nih.gov/training/indivpredoc/Pages/default.aspx> and be comprised of the following sections :

- 1. Title Page (1 page):** Include your name, exam committee members, oral exam date and location.
- 2. A Summary of the proposal,** the central question and its potential impact, in less than 30 lines of text.
- 3. Specific Aims (1 page):** Clearly and succinctly articulate the hypothesis to be assessed, the particular experiments (aims) that will be undertaken to address the hypothesis, and the expected outcomes of these aims and their relationship to the hypothesis.
- 4. Background and Significance (2-3 pages):** This section should clearly present the scientific significance of the problem chosen for investigation, provide the exam committee with sufficient material to understand the proposed hypothesis and aims, and present evidence that the hypothesis is reasonable and the proposed aims are feasible.
- 5. Research Strategy (4-5 pages):** This section should provide details of the proposed aims, expected outcomes and their relationship to the hypothesis, and caveats and alternative approaches for testing the hypothesis.

Please note: The total page limit for items **4** and **5** combined should not exceed **7 pages**. All **Figures** and their legends and **Tables** should be embedded in the document and count towards the page limit.

Biochemistry Ph.D. Program Guidelines

6. References (no page limit): The proposal should be referenced with appropriate scientific citations. Use a format that lists authors as well as the titles of the papers, e.g. *Cell* format. In addition, 3 primary literature references should be annotated with a few sentence description of the critical relationship of the work to the proposed hypothesis or aims.

7. Margin and Fonts: Margins and fonts should be as specified in the F30/F31 grant application.

The proposal is accompanied by a 30 minute oral presentation to the examining committee. The presentation is followed by questions from the committee about the proposal and about basic concepts and fundamental knowledge relevant to the research proposal and the student's chosen area of study.

Qualifying Exam: Key Deadlines

PhD Student Deadlines for topic submission and completion are as follows:

September 1st – Specific Aims Due

September 15th – Specific Aims Approved

Third week in October – Full Proposal Due to Committee Chair

First week of November – Feedback given to Student from the Chair

November - January – Exams are scheduled

7 Days before the Oral exam – Revised Full Proposal Due

MSTP Student Deadlines for topic submission and completion are as follows:

June 30 – Specific Aims Due

July 15th – Specific Aims Approved

August 19th – Full Proposal Due to Committee Chair

Week of September 1st – Feedback given to Student from the Chair

October – Exams are scheduled

7 Days before the Oral exam – Revised Full Proposal Due

The Steering Committee will appoint a qualifying examination committee composed of at least four Division members, based on the topic proposed and student nominations. Names of examiners nominated by the student should be submitted to the Steering Committee with the proposed topic(s). A student's thesis advisor will not be appointed to the examining committee. Two members of the Steering Committee will serve on the qualifying exam committee, one of whom will serve as chair.

During the first week of November the chair of the Committee will give the student critiques for the written document. The student is encouraged to communicate primarily with the chair for follow-up discussion as appropriate. The student is also free to solicit input from the thesis advisor or other faculty. The revised written proposal should be distributed to the entire qualifying examination committee no later than one week before the oral exam. No qualifying examinations shall meet unless all committee members are present.

Questions allowable during the examination include those directly related to the proposal, those that comprise background material leading to the proposal, and those that are judged to constitute

Biochemistry Ph.D. Program Guidelines

appropriate general knowledge for a Biochemistry student, based on the student's course work.

Passing/Failing the Qualifying Examination

Once the proposal is distributed, the exam must be held and the examining committee must either pass or fail the student. The pass/fail decision for the qualifying exam will be a binary one based on a majority vote (three of the four members must be in favor of passing) of the committee after the exam is complete. The chair will discuss the result of the exam to the student after the committee has deliberated. A passing grade may include a recommendation for remedial action but may not be contingent upon such action. A critique of the written and oral proposal will be given by the chair of the committee after completion of the exam.

For students who fail the qualifying exam, the chairperson will write a summary report to the student and the Steering Committee summarizing the deficiencies of the exam. If there are deficiencies in the proposal or in its defense of the proposal, these will be summarized. The Steering Committee will decide on the appropriate course of action. The Steering Committee may recommend that a student retake the exam only once and the second examination must take place within three months of the date of the first examination.

If there are deficiencies in the written proposal, the student will rewrite the proposal in order to remedy these deficiencies and submit to the committee within 2 weeks from receiving feedback. The original committee will review the revised proposal and determine if the student has passed the written portion.

If there are deficiencies in the oral part of the exam, either the defense of the proposal or the general knowledge section, the Steering Committee will determine if a new committee is needed or if the original committee can still serve on the retake exam. Based on the recommendations of the QE committee the Steering Committee will determine what parts of the oral exam the student will need to focus on for the retake.

If a student fails both parts of the exam, the second exam will be identical to the first exam in that the new committee will receive the written proposal to review before the meeting, the student will make a 30 minute summary of the proposal to the committee and the committee will ask questions related to both the defense of the proposal as well as general knowledge. The Steering Committee will decide whether a new proposal should be prepared or the original proposal used again and will give the second examining committee specific instructions on subject areas that should be emphasized in the questioning.

In each case when a new examination committee is recommended, this new committee will consist of the chair of the previous committee and three new members.

If a student fails the exam twice, any decision to dismiss the student or take other action will be made by the Biochemistry and Computational & Molecular Biophysics joint Steering Committee. The QE committee will restrict its deliberation and decision to the narrow issue of whether or not the student passes the examination in question.

Thesis Committee and Thesis Proposal

The purpose of the thesis committee is to advise the student in his or her thesis research and to provide the student with a readily accessible source of advice and constructive criticism during the dissertation research. To achieve these goals, it is imperative that thesis committees meet early in a student's term

Biochemistry Ph.D. Program Guidelines

and that they meet with the student at least once a year to offer suggestions and ascertain progress. The thesis committee should actively monitor the student's progress toward completion of a thesis by no later than the end of the fifth year. A thesis committee's ultimate responsibility is to act in the student's best interest, by ensuring that the research undertaken will lead to an acceptable dissertation and a Ph.D. degree.

Students should choose their thesis committees by the beginning of their third year (August/September). The thesis committee consists of four members and the thesis mentor. The University requires that the final dissertation defense committee be composed of at least five members, who normally meet two independent criteria:

1. Four of the five must be tenured or tenure-track Washington University faculty; one of these four may be a member of the Emeritus faculty. The fifth member must have a doctoral degree and an active research program, whether at Washington University, at another university, in government, or in industry.
2. Three of the five must come from the student's degree program; at least one of the five must not.

The student and preceptor nominate these committee members subject to approval by the Program Director. The committee members are selected for their expertise in relevant research areas and for their willingness to contribute advice and meet at least once per year. The committee is chaired by a faculty member other than the thesis mentor, and the chairperson should be designated in advance of the proposal, based on his or her willingness to be responsible for the committee's activities. The student and preceptor should view the committee system as a source of objective criticism and expert advice. At the time of the thesis defense, the thesis committee serves as the defense committee. The addition of committee members or changes of committee composition should be made no later than six months before the defense date.

All students must propose their thesis within six months after passing the preliminary exam. However, if a student feels a coherent proposal cannot be presented by that time, he or she may request permission from the Steering Committee to discuss informally the current project and likely future directions at the first meeting, as a Pre-Proposal meeting, and defer the formal proposal by no more than six months. **A student must propose their thesis by the end of the 5th semester. If the proposal is not completed within 6 months of this deadline, the student will lose their good academic standing status and could be dismissed.**

If a student chooses to have a pre-proposal meeting, then the student should provide a written description to their committee, one week before the meeting, briefly outlining their progress in the lab and their thoughts and ideas about what might constitute their thesis proposal.

The thesis proposal should include a statement of purpose and rationale for the project, an outline of the methods to be used and an assessment of their feasibility, a summary of the work performed to date, an idea of the potential outcome, and alternative plans for high risk portions of the project. Although these are all essential components of a proposal, it is not intended that the proposal be lengthy, and preliminary data, while desirable, need not be profuse or conclusive. One week prior to these meetings, the student must provide a written document to the committee outlining progress and future direction. A single-spaced proposal, with references, of five-to-ten pages is appropriate. The thesis proposal meeting provides a student with guidance in selecting appropriate research goals. It is not a test that the student must pass or fail.

Biochemistry Ph.D. Program Guidelines

During the thesis proposal, emphasis should be given to the student's understanding of the proposed research and the likelihood that it will allow the student to produce a thesis in a timely manner. Toward this end, it is customary for the thesis advisor, although present, not to participate in the discussion except where specifically requested to do so by a thesis committee member. For both the proposal and for subsequent thesis committee meetings, the committee will meet briefly to prepare its recommendations with the student absent. On occasion, the committee may also choose to meet with the student with the thesis advisor absent.

After the proposal has been approved, thesis committees will meet with students no less than once a year. Scheduling of the meetings should be done by the student, who will also submit a written progress summary to the committee members no later than one week prior to the meeting. In the event that a student does not schedule timely meetings, the thesis committee chairperson will schedule the meetings. The thesis committee may choose to meet more often than once per year, if it finds more frequent meetings appropriate. After each meeting, the thesis committee chairperson will be responsible for ensuring that recommendations of the committee are communicated to the student and the Division Office.

Conflict of Interest

Research funding from sources that have intellectual property interests in the research, or in which the PI has personal financial interest, may create a real or perceived conflict of interest, given the dual roles of the principal investigator in obtaining funding for the lab and as a mentor for graduate students. Issues of paramount importance are (i) the ability to publish results in a timely fashion; (ii) the ability to communicate research results openly, especially to members of the thesis committee; and (iii) academic rights to publish and speak freely, especially as related to a graduate student's thesis and defense.

Statement of policy

The following principles should apply to any situation involving a graduate student supported by funding that is associated with a confidentiality agreement:

The limitations and nature of the confidentiality agreement must be fully disclosed to and approved by the student, the thesis committee, and the DBBS Associate Dean for Graduate Affairs;

The confidentiality agreement must not place an unreasonable burden or delay in publication or reporting at scientific meetings;

The confidentiality agreement must not delay the writing or defense of the thesis.

The complete Conflict of Interest policy can be viewed at:

<http://www.dbbs.wustl.edu/curstudents/DBBSStudentPolicies/Pages/ConflictofInterestPolicy.aspx>

The Ph.D. Dissertation and Thesis Defense

The Biochemistry Program is designed with the goal that students complete their thesis research and prepare, present, and defend a Ph.D. dissertation four to five years from the time they begin the program. For MSTP students, the time line for the graduate component is approximately one-to-two year less because of the partially interleaved curriculum. The dissertation must be based upon an original investigation which results in a significant contribution to knowledge in the field of

Biochemistry Ph.D. Program Guidelines

biochemistry. Subject to approval of the thesis committee, the dissertation may include reprints of published work of which the student is the first author. When published material is included, an introductory statement must describe the extent of the candidate's contribution to both the experimental work and the preparation of the manuscript. When published material constitutes a significant fraction of the dissertation, it is desirable that separate introduction (background) and discussion (significance) chapters be contributed by the student.

In order to assure that the dissertation will meet with general approval of the thesis committee and to provide the required notice to the graduate school of the oral defense, the student will present an outline of the dissertation to the thesis committee six months before the defense date, and meet with the committee to discuss the outline and gain its approval. Once a date for the defense has been set, the Division Office should be notified promptly.

The thesis committee must read the dissertation *prior* to the oral defense. To allow adequate time for this and to remedy potential problems, a *complete* draft of the dissertation must be given to the thesis committee *at least two weeks prior to the date of the defense*. Unless otherwise requested by the student and advisor and agreed to by the thesis committee, the format of the defense will be a public seminar followed by a closed session with the entire thesis committee.

Students' Responsibility to Meet Program Requirements

Graduate students in the Biochemistry Program are responsible for completing requirements in a timely fashion. In particular, the requirements for courses, preliminary examinations, thesis proposals, and thesis committee meetings are important components of graduate training and should be regarded seriously. In the event that a student has trouble meeting any requirement, they should request consideration of their situation by the Steering Committee, which may postpone or waive the requirement.

Transfer From and To Outside Programs

Students are free to transfer to the Biochemistry Program from any other program in the Division of Biology and Biomedical Sciences. Students who transfer will be expected to meet all of the normal requirements of the programs, although special exceptions may be granted in rare cases by the Steering Committee. Students also are free to transfer from the Biochemistry Program to an outside program. *A transfer to a different program can be made only if the student is in good academic standing, as defined by Division guidelines.* Transfer is accomplished most easily during the first year, but can be done at later times, if necessary. Any student considering a program transfer should consult with the directors of the programs involved.

MSTP Students

Students who join the Biochemistry Program through the Medical Scientist Training Program complete the same requirements as Ph.D. students. However, every effort is made to eliminate redundancies in the curriculum and to streamline the program where possible. For example, Bio 5325 or 5068 can be substituted for Molecular Foundations of Medicine in the first year medical curriculum and taken at that time. Therefore, the first graduate year for MSTP students would normally consist of two courses in the fall and two in the spring. The prelim exam would then be completed by the end of the summer.

Biochemistry Ph.D. Program Guidelines

The program is designed so that the graduate requirements (except thesis research and possibly special topics/journal clubs) can be completed by the end of the first full graduate year.

Publications

There is no specific requirement for publication to receive the Ph.D. However, high quality, peer-reviewed publications are an important determinant for a student's career. Similarly, the process of writing and submitting a manuscript and responding to reviewer critiques is an essential part of a student's training. Therefore, the publication record is one of several important and appropriate measures to be used by a thesis committee in evaluating a Ph.D. candidate. It is generally expected that students will have submitted and/or published one or more first author manuscripts in peer-reviewed journals at the time of the defense.

Academic standing

The Program, Division, and the Graduate School have multiple requirements for graduate students to remain in good academic standing. Failure to maintain these standards may result in being placed on academic probation. Academic probation serves three purposes:

1. Explicitly warn the student of his or her status,
2. Provide the student with clear guidelines of the performance that will be necessary to return to good standing
3. Offer the student reasonable time to meet these expectations.

We stress that the purpose of academic probation is not punitive. It is a mechanism to help establish firm milestones through each student's training, and to ensure follow through by all parties towards those milestones.