Biological Sciences – Chemistry-Biology Interface Concentration (PhD)

Program Educational Goals:

The central mission of the PhD program in Biological Sciences is to train students in an inclusive environment to think creatively to drive scientific inquiry and to work collaboratively to address significant challenges in the life sciences.

Our program will achieve this mission through the following educational goals:

1. Core Concepts: Acquire a breadth of knowledge in Chemistry-Biochemistry Interface, as well as in-depth expertise in the student's specific area of study and how their research fits into the broader framework of biology. For details: click here.
2. Critical Thinking Skills: Develop the ability to critically evaluate primary literature and identify key scientific questions as well as approaches to address them demonstrated through written and oral communication.
3. Research Skills: Develop skills that demonstrate independent scientific thinking, interpretation, and application. These include the ability to formulate testable hypotheses based on theory and empirical research, design a scientific research plan that tests these hypotheses, and acquire the technical skills necessary to implement a research plan to discover new knowledge in life science. Build analytical skills that enable rigorous qualitative and quantitative scientific data evaluation.
4. Scientific Communication Skills: Develop scientific writing skills necessary for publication of primary research, literature review, and preparation of independent fundable research proposals. Develop a strong foundation in oral presentation that enables students to share scientific information and ideas to both specialized and general audiences.
5. Professional Development Skills: Develop skills in advancing their career by participating in opportunities for networking, collaborations, mentoring, working in diverse groups, and taking on leadership roles.

Requirements for the Degree:

The prospective student must meet all general requirements for the Ph.D. degree in the Department of Biological Sciences. The curriculum described below was developed to ensure that students achieve the breadth of knowledge, written and oral communication skills, and proficiency in the practice of research expected of individuals holding an advanced degree with a specialization at the interface of modern Biology and Chemistry. All students are expected to have basic competency in biochemistry, molecular biology and genetics upon admittance to the program since these fields underpin the training provided in this concentration. Competency in Molecular Biology and Genetics is primarily assessed by the student's performance on the oral comprehensive exam. However, all students are required to take a written diagnostic exam or equivalent after one semester of enrollment to help them assess their level of preparation for the

comprehensive exam. The results of this exam will be discussed with the student by the concentration coordinator to help the student plan a strategy to prepare for the comprehensive exam.

Required Courses:

- BISC 602 - Molecular Biology of Animal Cells - Credit(s): 3
- CHEM 606 - Introduction to Research at the Chemistry/Biology Interface Credit(s): 3 [1]
- BISC 612 - Advanced Cell Biology - Credit(s): 3
- BISC 654 - Biochemical Genetics – Credit(s): 3
- BISC 827 - Graduate Research Seminar[2] - Credit(s): 1 credit every semester
- BISC 850 - Advanced Topics in Biology - Credit(s): 1

Notes:

[1] CHEM 606 consists of three tutorials (laboratory rotations) plus attendance at the Chemistry-Biology Interface seminar.

[2] BISC 827 - Graduate Seminar is required every fall and spring semester while enrolled as a student. Students will present oral summaries of their laboratory tutorials or ongoing research.

Electives:

Students must take either two courses from the following list of three- and four-credit courses, or one course from this list plus three one-credit sections of BISC850.

BISC 605 - Advanced Mammalian Physiology Credit(s): 4
BISC 606 - Advanced Mammalian Physiology II Credit(s): 4
BISC 615 - Developmental Biology Credit(s): 3
BISC 639 - Developmental Neurobiology Credit(s): 4
BISC 643 - Biological data analysis Credit(s): 3
BISC 656 - Evolutionary Genetics Credit(s): 3
BISC 671 - Cellular and Molecular Immunology Credit(s): 4
BISC 675 - Cardiovascular Physiology Credit(s): 3
BISC 682 - Bacterial Pathogens: Molecular Mechanisms Credit(s): 3
BISC 690 - Fundamentals of Pharmacology Credit(s): 3
BISC 693 - Human Genetics Credit(s): 3
BINF 644 - Bioinformatics Credit(s): 3
BINF 694 - Systems Biology I Credit(s): 3
CHEM 624 - Principles of Mass Spectrometry Credit(s): 3
CHEM 643 - Intermediary Metabolism Credit(s): 3
CHEM 644 - Mechanisms of Enzyme Catalysis Credit(s): 3
CHEM 645 - Protein Structure and Function Credit(s): 3
CHEM 646 - DNA-Protein Interactions Credit(s): 3

CHEM 830 - Special Topics in Organic Chemistry Credit(s): 1-3

MAST 625 - Microbial Physiology and Diversity Credit(s): 3

Note:

If any graduate courses equivalent to those listed above have been taken in previous graduate degree programs and have been accepted as graduate level transfer credit by the University, the transferred courses may be used to satisfy the Concentration requirements with the approval of the Concentration coordinator.

Other three- or four-credit courses at the University may be used to fulfill the elective requirement if approval from the Concentration coordinator is received prior to taking the course.

The Comprehensive Examination

Graduate students in the Chemistry-Biology Interface Concentration are expected to possess a fundamental body of knowledge in biochemistry equivalent to CHEM 641, molecular/cellular biology equivalent to BISC 401, and genetics equivalent to BISC 403, as well as the ability to critically analyze scientific literature. See the core competency list for more details. To ensure that this is the case, an oral comprehensive examination will be administered to all graduate students in the Concentration.

In order to be eligible to take the comprehensive exam, students must have completed first year core courses (BISC 602, BISC 612 and BISC 654) with a grade of B or better. Students are required to take the comprehensive exam at a time set by the Concentration Coordinator for as soon as feasible after the first year curriculum has been successfully completed. If the student fails to complete the comprehensive exam by this time, the student will be subject to dismissal.

Procedure

Students will be provided with at least four sets of papers from the primary literature selected by faculty, from which they must choose one set as the basis for their oral examination. These papers will be available at least three weeks before the exam, so that the exam can be administered the first or second week of June for students admitted the previous summer or fall. Students admitted in the spring will usually have paper sets available by December 10 so that the exam can be administered in early January. Two weeks prior to the exam, the student should inform the Concentration coordinator of the chosen paper set. Prior to the exam, the student should prepare slides of all of the figures and tables presented in the papers so that they will available for discussion during the exam.

During the exam, the student will be tested by a committee of three to six faculty on the student’s comprehension of all aspects of the paper and the core competencies. Students will present a synopsis of the primary paper, then the examination committee will ask questions pertaining to the paper. The committee will also ask questions pertaining to the core competencies. Prior to the exam, students are encouraged to contact faculty to discuss the topics they are responsible for and to clarify difficult concepts.

Grading

The comprehensive exam committee will grade the student based on:

- the quality of the student's oral presentation of the primary paper and background information;
- the student's understanding of the background, methods, results, interpretation, and overall significance to the field of the primary paper;
- the student's understanding of the topics in the list of core competencies.

After the oral examination, the examination committee will determine an appropriate grade. Four grades are possible at the initial exam:

1. Unconditional pass. The student may proceed to the next stage of the degree training.

2. Conditional pass. The student performed marginally in one or more areas and may be asked to complete (with a grade of B or better) one or more courses as a condition for changing the grade to pass. The examination committee may prescribe conditions in addition to, or in lieu of, course enrollment. Once the condition is fulfilled, the student is responsible for informing the Biology Graduate Program Director so that the grade can be changed officially.

3. Re-examination. This result is appropriate for a student whose performance was unsatisfactory, but displayed evidence of the potential to complete graduate degree training. Re-examination must be completed within eight weeks of the initial exam, at a time to be set by the examining committee. The possible outcomes of the re-examination are unconditional pass, conditional pass or failure. The student may not take the exam a third time.

4. Failure. This outcome would indicate that examination committee considers the student incapable of completing degree training. The student's academic progress will be reviewed by the Graduate Affairs Committee, who will make recommendations to the Department Chair regarding the student's enrollment status. The Chair may recommend to the Office of Graduate & Professional Education that the student be dismissed from the Program immediately.

Once the student passes the comprehensive examination, the student becomes eligible to take the qualifying examination for advancement to Ph.D. candidacy.

The Ph.D. Candidacy Examination

The purpose of the oral candidacy examination is to give the student the opportunity to demonstrate:

- the ability to formulate a research problem and to comprehend its significance;
- the ability to design appropriate experimental approaches to solve the problem;
- the ability to write and defend a research proposal;
- an understanding of the research area in which the student is interested.

Ph.D. Research Proposal

At the end of the student's third year, the student is expected to have spent at least two years working on a research project in the laboratory of the dissertation advisor. At this time the student, in consultation with the dissertation advisor, will prepare a proposal in the format described below that outlines the background of the project, the hypothesis to be tested, the research accomplishments to date and the research to be completed to

fulfill the requirements of a Ph.D. in Biological Sciences. It is the student's responsibility to submit the Research Proposal to each member of the dissertation committee at least two weeks prior to the oral exam date.

The Research Proposal must be double-spaced, in 12-point Arial or Palatino, and include:

- Specific Aims: State concisely and realistically what the research is intended to accomplish, what hypothesis is to be tested, and specific aims to address the hypothesis. Do not exceed two pages.
- Background and Significance: Briefly sketch the background to the present proposal, critically evaluate existing knowledge, and identify gaps that the proposed research is intended to fill. State concisely the importance of the research by describing the overall significance to the field of each specific aim. Do not exceed 10 pages.
- Preliminary Research. Summarize preliminary data relevant to the proposed research, and briefly describe other research accomplishments. Do not exceed 10 pages.
- Research Design and Methods: Briefly summarize the experimental design and the procedures to be used to accomplish the specific aims of this research. Include a description of the types of data to be obtained and how they will be analyzed to accomplish the specific aims. Students must be prepared to discuss potential pitfalls in the experimental design and contingency plans in the event that the data run counter to expectations. The description of each experiment must explain its significance to the overall goals of the project. Do not exceed 15 pages.
- Literature Cited: All citations must include all author names as well as article titles. A suggested format (the standard for Journal of Cell Science for EndNote users) is:

Mazaki, Y., Uchida, H., Hino, O., Hashimoto, S. and Sabe, H. (1998). Paxillin isoforms in mouse. J. Biol. Chem. 273, 22435-22441.

Exam for admission into candidacy for the Ph.D. (Qualifying exam)

The exam will be administered by the student's dissertation committee, excluding the student's primary research advisor. If a student has co-advisors with major roles in supervising the student's research, the co-advisors may not serve on the examination committee. If a student whose research is supervised by someone outside the Department has an advisor of record who does not play a primary role in supervising the student's research, the advisor of record may serve on the exam committee. The exam committee must have at least three members, and at least two of the members must have primary appointments in Biological Sciences. Temporary members may be added to the dissertation committee to meet these requirements. It is not necessary to have a member of the exam committee from outside the Department.

Since the primary advisor for the dissertation will not be present during the examination, the student must choose an examination committee chair from among the remaining members. The chair will be responsible for the conduct of the exam and the completion of a detailed report outlining the student's strengths and weaknesses, as well as any suggestions for alterations to the research proposal after the defense.

At the oral defense, the student will present the background and significance of the work, the hypothesis to be tested and the preliminary data collected. The majority of the presentation should be devoted to explaining the research to be performed in the two years remaining in the student's degree program. Students should plan on a 30-45 minute presentation, throughout which the committee will ask questions. At the conclusion of the formal presentation the committee will evaluate the student's scientific background as well as the scientific validity of the proposed research project. It also is essential that the student demonstrates the ability to make a significant intellectual contribution to the project.

Grading

A student's performance will be regarded as satisfactory only if the student:

- demonstrates an adequate knowledge of the field in general as well as the research specialty in which the student is interested;
- formulates a research problem, the solution of which will make a substantial contribution to our existing knowledge;
- demonstrates that the experimental design and methods proposed are appropriate to solving the problem;
- writes and defends a proposal that meets the scholarly expectations of the field.

After the oral examination, the examination committee will determine an appropriate grade. Four grades are possible:

- Unconditional pass. The student will be admitted into candidacy and should arrange for the appropriate paperwork to be filed with the graduate office.
- Conditional pass. The student was deficient in one or more areas. The examination committee will prescribe conditions that the student must complete. Once the condition is fulfilled, the student is responsible for informing the Biology Graduate Program Director so that the student can be admitted into candidacy.
- Re-examination. Deficiencies are severe. The student must re-take the exam at a time to be determined by the committee, but no later than 6 months after the initial exam. The possible outcomes of the re-examination are unconditional pass, conditional pass or failure. The student may not take the qualifying exam a third time.
- Failure. This outcome would indicate that the examination committee considers the student incapable of completing Ph.D. training. The student's academic progress will be reviewed by the Graduate Affairs Committee, who will make recommendations to the Department Chair regarding the student's enrollment status. The Chair may recommend to the Office of Graduate & Professional Education that the student be dismissed from the Program immediately, or may recommend that the student be transferred to the Master's program and be ineligible for the Ph.D. in Biological Sciences.

Suggested Schedule:

Year One:

Fall Semester

Course Name and Number Credits

BISC 602 - Molecular Biology of Animal Cells - Credit(s): 3

BISC 612 - Advanced Cell Biology - Credit(s): 3

CHEM 606 - Introduction to Research at the Chemistry/Biology Interface- Credit(s): 3

BISC 827 - Graduate Research Seminar - Credit(s):1

Teaching assistantship, development of oral presentation and teaching skills

Total: 10 credits

Winter Session

- Second laboratory tutorial

Spring Semester

Course Name and Number Credits

BISC 654 – Biochemical Genetics - Credit(s): 3

BISC 827 - Graduate Research Seminar - Credit(s): 1

BISC 850 - Advanced Topics in Biology - Credit(s): 1

BISC 868 - Research in the laboratory of chosen dissertation advisor - Credit(s): 5

Teaching assistantship, development of oral presentation and teaching skills

Total: 10 credits

Summer Session

early June

- Comprehensive examination

late June, July and August

- BISC 868 - Research in the dissertation laboratory (3 credits)
- Identification of Advisory Committee and first committee meeting

Year Two:

Fall Semester

Course Name and Number Credits

Elective - Credit(s) 3

BISC 827 - Graduate Research Seminar - Credit(s) 1

Research in dissertation laboratory - Credit(s):4-6 (BISC 868 for students who have unconditionally passed comprehensive exam, or BISC 964 for students who have not unconditionally passed comprehensive exam)

Total: 8-10 credits

Spring Semester

Course Name and Number Credits

Elective - Credit(s) 3

BISC 827 - Graduate Research Seminar - Credit(s) 1

BISC 964 - Research in dissertation laboratory - Credit(s) 6

Total: 10 credits

Years Three-Five:

Until successful completion of qualifying exam:

Course Name and Number Credits

BISC 964 - Pre-candidacy Study - Credit(s) 6

BISC 827 - Graduate Research Seminar - Credit(s) 1

Total: 7 credits

After completion of qualifying exam:

Course Name and Number Credits

BISC 969 - Doctoral Dissertation - Credit(s) 9

BISC 827 - Graduate Research Seminar - Credit(s) 1

Total: 10 credits