[These are the four Track Documents approved by the Biological Sciences faculty at a faculty meeting on Feb. 27, 2007. Because the earlier versions of the Track Documents were never approved at any administrative level above Biological Sciences, changes to the previous Track Documents are not shown.]

Cell and Organ Systems Track Policy and Curriculum

The Cell and Organ Systems Graduate Track encompasses a wide diversity of research areas, including cell biology, organ systems physiology, extracellular matrix biology, cell signaling, developmental biology and others. It is anticipated that, given the enormous increase in gene sequence data available, there will be an increasing need for individuals broadly trained in disciplines such as these. The goal of this track is to provide students a rigorous environment and careful guidance in their efforts towards earning a graduate degree. The curriculum provides for a breadth of background knowledge, skill development in oral and written communication and in critical thinking and opportunities for learning a variety of research techniques. Both M.S. and Ph.D. degree programs will emphasize the development and critical defense of an independent research project.

Students wishing to enter this track are expected to have some background (at the undergraduate or graduate level) in general physiology, biochemistry and genetics/evolutionary biology. The requirements for the Ph.D. Degree include 16 credit hours of selected graduate level coursework, a series of 3 Laboratory Tutorials or rotations, at least 2 semesters of teaching experience (as a Teaching Assistant) and successful completion of a Graduate Preliminary Exam, a Ph.D. Candidacy Exam and a Dissertation Defense. Ph.D. students also take at least 9 credits of BISC 969 - Doctoral Dissertation, after passing the Candidacy Exam.

Students in the M.S. Degree program will take the same 16 credit hour core curriculum, a minimum of 8 credits of Research (BISC 868 to total at least 22 credits), plus 6 credits of BISC 869 - Master's Thesis. M.S. students are not required to specifically take Laboratory Tutorials, but may opt to as a way of identifying a primary thesis advisor. There is no candidacy exam for M.S. students; instead they become qualified to defend their Master's Thesis following successful completion of the Graduate Preliminary Exam.

The curriculum outlined below conforms to both department of Biological Sciences and University of Delaware policy. (see "Departmental Graduate Program Policy").

Graduate Curriculum

Year One: Fall Semester

Course Name(s) and Number(s)	**Credits**
BISC 605 - Advanced Mammalian Physiology	3
BISC 827 - Graduate Seminar[1]	1
Teaching Assistantship[2]	0
BISC 864 - Research (Laboratory Tutorials: 2 at 2 credits each)[3]	4

Winter Session

Course Name(s) and Number(s)	**Credits**
BISC 864 - Research (Laboratory Tutorial)	2

Spring Semester

Course Name(s) and Number(s)	Credits
BISC 612 - Advanced Cell Biology	3
BISC 827 - Graduate Seminar	1
Teaching Assistantship	0
BISC 868 - Research	Variable

Summer Session

Course Name(s) and Number(s)	Credits
Graduate Preliminary Exam -	
BISC 868 - Research	Variable

Year 2: Fall Semester

Course Name(s) and Number(s)	Credits
BISC 6XX – Elective	3
BISC 827 - Graduate Seminar	1
Teaching Assistantship	0
BISC 868, BISC 869 - Master's Thesis or BISC 964[4]	Variable

Spring Semester

Course Name(s) and Number(s)	Credits
BISC 806 - Current Topics in Cell and Organ Systems, or BISC 833 - Special Topics in Biology	3
BISC 827 - Graduate Seminar	1
Teaching Assistantship	0
BISC 869 - Master's Thesis or BISC 964 - Research	6

Notes

1. BISC 827 - Graduate Seminar is required every fall and spring semester. Students will present oral summaries of their laboratory tutorials or ongoing research.

2. For Ph.D. students, Teaching Assistantship will be awarded to (usually) new graduate students as part of their requirement to gain teaching experience. At least two semesters, but no more than 4 semesters (two years) will be supported on TA stipends. For M.S. students, there is neither a minimum requirement, nor a 2 year limit of TA support. Generally, the TA carries with it an expectation of 20 hours/week, including in-class/laboratory time, preparation, grading, etc.

3. For the Ph.D. program, BISC 864 credit will include, during the first year, three two-credit Laboratory Tutorials or rotations in 3 different research labs (one of which will ultimately be chosen as the primary research lab). Generally, two of these tutorials will be taken during the first semester (6 weeks each) and the third during the following Winter Session. Additional BISC 868 credits during the following spring semester will be considered research credit, assigned by the student's primary research advisor. M.S. students are not required to take Laboratory Tutorials. Instead, BISC 868 (variable credit hours) may be used as research credit in the primary research advisor's lab.

4. BISC 869 - Master's Thesis, should be taken by M.S. students who have passed the Graduate Preliminary Exam. BISC 964 is intended for Ph.D. students who have passed the Graduate Preliminary Exam and have Pre-Candidacy status.

Graduate Electives

The following list of graduate courses are those that can be used as Electives in the Cell and Organ Systems Track. However, other courses, including selected courses from other departments may also be included, with approval of the student's thesis/dissertation committee or of the Graduate Programs Committee. If a graduate level course similar in content to any of these has been accepted as graduate level transfer credit by the University, the transferred course may be used to satisfy the Track requirements with the approval of the Track coordinator.

BISC 602 - Molecular Biology of Animal Cells

BISC 615 - Vertebrate Developmental Biology

BISC 618 - Computer Imaging in Biology

BISC 625 - Cancer Biology

BISC 630 - Icthyology

BISC 631 - The Practice of Science

BISC 639 - Developmental Neurobiology

BISC 645 - Bacterial Evolution

BISC 656 - Evolutionary Genetics

BISC 660 - Environmental Physiology

BISC 665 - Advanced Molecular Biology & Genetics

BISC 667 - Biological Statistics

BISC 671 - Cell and Molecular Immunology

BISC 675 - Cardiovascular Physiology

BISC 679 - Virology

CHEM 641 - Biochemistry

PLSC 635 - Plant Developmental Biology

PLSC/BISC 646 - Plant Cell Biology

PLSC 666 - Plant Physiology

Thesis/Dissertation Committees

Based on tutorials and discussions with different faculty members, students should choose a primary research advisor as soon as possible and prior to the end of their first academic year in the program. This advisor must have a primary or secondary appointment in the Department of Biological Sciences. With the help of the advisor, the student should then select 4-6 additional advisory committee members (minimum of 2 for MS thesis committees), one of whom must have a primary appointment outside the Department of Biological Sciences. It is expected that students will meet at least twice-yearly with their committees (see Graduate Program Policy).

Graduate Preliminary Exam in the Cell and Organ Systems Track

All graduate students in the Cell and Organ Systems Track must take an oral "Graduate Preliminary Exam," the purpose of which is to evaluate both breadth of knowledge (see the core competency list for more details) and the ability to assimilate and critically evaluate published scientific work in the field. In order to be eligible to take the preliminary exam, students must have completed first year core courses (BISC605 and BISC612) with a grade of B or better. In all cases, the student is expected to correct all deficiencies in their performance in the first year curriculum by the end of the semester after the deficiency occurred but no later than the end of their third semester in the program. If the applicable course is not offered, a suitable substitute will be determined by the Track coordinator. Failure to obtain a B or better in a required course in the second attempt will make the student subject to dismissal from the graduate program. Students are expected to take the preliminary exam within six weeks after the first year curriculum has been successfully completed. If the student fails to complete the preliminary exam by this time, the student will be subject to dismissal.

The examining committee (4 track members appointed by the track coordinator each year) will assemble a selection of scientific articles and screen these for consistency in terms of depth and breadth of information covered. Each article will have associated with it, 2-3 secondary or "backup" papers that provide additional background on the topic. The committee will eventually select a candidate pool of 3-4 of these collected papers to present to the students taking the exam. Each student will read through the articles and eventually select one (along with its designated backup papers) to be the basis of their prelim exam. This selection must be communicated to the examining committee.

The student will then be responsible for demonstrating a thorough understanding of all aspects of this work, including tangential areas of methodology, interpretation of results, significance in the context of other work in the field, and any related background (die physiology, anatomy, biochemistry, cell biology, etc). Some questions may derive from published articles or textbook materials that are not specifically included in the paper set; it is up to the student to determine what areas they may need to further study by, for example, carefully reviewing the bibliography of the selected article. The student should have prepared a collection of overheads or slides of all figures and tables from the papers, which may be used during the questioning. Students may consult with members of the examining committee prior to the exam to clarify information or breadth of coverage.

An approximate timetable is as follows:

May 1: Examining Committee makes available to students the selected paper sets

June 1: Each student informs the Examining Committee of their selection

June 15-30: Administration of prelim exam (individually)

There are four possible outcomes: unconditional pass, conditional pass, re-examination, or failure. The student will be informed of the outcome after brief deliberations of the committee and this outcome will also be transmitted to the Graduate Program Director. A conditional pass may be appropriate if the committee felt that the student did not have an adequate background or understanding in one or more specific areas. The conditional pass will be communicated to the student along with specific requirements for strengthening these areas and completing the unconditional pass. These requirements may include one or more specific courses, which must be completed with grades of B or better, specific Teaching Assistantship assignments, special problems or others. The student must inform the Graduate Program Director and the track coordinator when these conditions have been completed. In cases where the committee feels there are more significant problems in background or communication skills the committee may decide on a re-examination. This will be done using the same format and prior to the beginning of the next academic semester. If the student still does not perform satisfactorily on this re-examination, he/she will then be terminated from the track. Finally, the examining committee may find that a candidate lacks the skills or motivation to successfully complete a graduate program and may then decide on failure without the possibility of re-examination.

M.S. students who successfully complete the Graduate Preliminary Exam are eligible to finish and defend a Master's Thesis. Ph.D. students must additionally complete a Ph.D. Candidacy (Qualifying) Exam.

Ph.D. Candidacy Exam

The Ph.D. Candidacy Exam consists of two parts:

1.a comprehensive, formal written Research Proposal

2.an oral exam (qualifying exam)

The purpose of this requirement is to determine whether a candidate for the Ph.D. degree has reached the level of critical understanding of their own selected research area to make an independent and significant contribution to that field. Specifically, the exam should determine the student's ability to identify a specific problem or question, design appropriate experiments to address this problem, critically evaluate shortcomings or potential pitfalls and to effectively communicate the importance and significance of their work in the context of ongoing research in that area (i.e., knowledge of the primary research literature). The Candidacy Exam should be taken before the end of the student's sixth academic semester.

The Candidacy Exam is administered by an examining committee consisting of 4-5 members of the Dissertation Committee, but excluding the primary research advisor. The student should choose one member of this group to serve as chairperson, who will then be responsible for coordinating the exam and for writing a detailed report on the outcome. This report may include perceived strengths and weaknesses, as well as specific recommendations for changes or modifications in the student's research plan. The student and chairperson should agree on a specific date for the oral portion of the exam.

Research Proposal. The student will be responsible for independently writing a detailed research proposal, following a format that would be used for an NIH grant proposal. This should include the following sections:

1.specific aims

2.background and literature review, including critical assessment of the field and how the proposed research will contribute to it

3.a statement of how the specific aims might relate to long term goals

4.a detailed summary of proposed experiments and methods to be used.

This latter section should also include a description of how the results will be analyzed, as well as potential pitfalls and contingency plans for dealing with unforeseen obstacles. All cited work should be fully referenced with complete authors and titles. If appropriate, a Prelim Results section may also be included; however, the major portion of the oral exam will focus on the proposed work. The proposal should be an actual, realistic outline of the work the student expects to complete during the remaining time here. The proposal should be presented to members of the Dissertation (Examining) Committee at least two weeks before the exam date.

Qualifying Exam. The oral exam will consist of an initial, 30-45 minute presentation by the student, summarizing the research proposal and preliminary results. Generally, this portion should be uninterrupted, except for occasional questions for clarification (i.e., a seminar format). The major part of this presentation should focus on the experiments yet to be done, the methods to be used and the strategies behind the experimental approach. Following this presentation the committee members will ask questions related to all aspects of the proposal, including literature and background, methods and significance. The goals of this exam are to assess both the preparedness and critical thinking ability of the student and the feasibility and validity of the proposed work. The student may meet with members of the committee before the exam to determine topics and areas that that member might feel are appropriate to cover in the exam. As with the Graduate Preliminary Exam, the four possible outcomes of the Candidacy Exam are: unconditional pass, conditional pass, re-examination, or failure. Again, the examining committee may make specific recommendations for changes in the proposal or in the student's preparation, in order to revert a conditional pass into an unconditional pass. Likewise, a re-examination will require significant re-writing of the research proposal and a second Qualifying Exam. If the Examining Committee determines that a student has failed, either on the first or second round, a recommendation may be made for either terminating the student from the graduate program or offering a terminal M.S. degree.

Thesis/Dissertation Defense

Both the M.S. Thesis and Ph.D. Dissertation must be defended in a public presentation. The format is a formal seminar summarizing the work done and its significance, followed by general questions from the audience and, finally, a questioning period by the Thesis/Dissertation Committee

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Ecology and Evolution Track Policy and Curriculum

The prospective student must meet all of the requirements for the M.S. or Ph.D. degree in the Department of Biological Sciences, as shown in the departmental Graduate Program Policy. In addition to the departmental requirements, the specific curriculum required for the Ecology and Evolution track, for both M.S. and Ph.D. students is:

1. One year of graduate level statistics, specific courses to be decided in consultation with the major advisor.

2. BISC 637 - Population Ecology

3. One graduate level evolution course. Courses at University of Delaware that currently meet this requirement are BISC 656 - Evolutionary Genetics, and CHEM 647 - Biochemical Evolution.

4. BISC 801 - Seminar in Ecology and Evolution whenever it is taught.

5. In consultation with the Advisement Committee, students may elect to take other graduate level courses appropriate to their degree program. These may include but are not limited to: BISC 641 - Microbial Ecology, BISC 660 - Environmental Physiology, ENTO 614 - Insect Ecology, ENTO 620 - Behavioral Ecology of Insects, and a graduate level course in molecular methods.

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 Track requirements with the approval of the Track coordinator.

Molecular Biology and Genetics Track Policy and Curriculum

For students matriculated February 1, 2007 and later

The prospective student must meet all general requirements for the M.S. or 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 in Molecular Biology and Genetics. 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 track. The biochemistry competency must be demonstrated by superior performance in a biochemistry course from another institution or by completing CHEM 641 (Biochemistry) with a B or better in the first semester of graduate enrollment. Acceptance of courses from other institutions is subject to approval by the Track Coordinator. Competency in Molecular Biology and Genetics is primarily assessed by the student's performance on the oral preliminary 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 preliminary exam. The results of this exam will be discussed with the student by the track coordinator to help the student plan a strategy to prepare for the preliminary exam.

Fall, Year One

Course Name(s) and Number(s)	**Credits**
BISC 602 - Molecular Biology of Animal Cells	3
BISC 864 - Two laboratory tutorials (2 credits under two different section numbers)*	4

BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
Teaching assistantship, development of oral presentation and teaching skills	0

Total: 8 credits

Winter, Year One

Molecular Biology and Genetics diagnostic exam

Third laboratory tutorial*

Spring, Year One

Course Name(s) and Number(s)	**Credits**
BISC 654 - Biochemical Genetics	3
BISC 868 - Research in the laboratory of chosen thesis/dissertation advisor	2
BISC 864 - Laboratory tutorial* (registration for winter session tutorial)	2
BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
Teaching assistantship, development of oral presentation and teaching skills	0

Total: 8 credits

*M.S. students are encouraged to identify an advisor without tutorials. In this case, they would register for the appropriate number of BISC 868 credits instead of tutorial research. Such students should also form their thesis committee and have their first meeting by March of the first year.

Summer, Year One

June

Preliminary examination

July and August

3 credits: BISC 868 - Research in the thesis/dissertation laboratory

Identification of Advisory Committee and first committee meeting

Fall, Year Two

Course Name(s) and Number(s)	**Credits**
BISC 665 - Advanced Molecular Biology and Genetics	3
BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
Research, in thesis/dissertation laboratory	4-6
BISC 964 - Ph.D. students who have unconditionally passed Preliminary exam	

BISC 869 - M.S. students who have unconditionally passed Preliminary exam
BISC 868 - Students who have not unconditionally passed preliminary exam

Total: 8-10 credits

Spring, Year Two (Ph.D. students)

Course Name(s) and Number(s)	**Credits**
BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
BISC 964 - Research, in thesis/dissertation laboratory	6
From elective list	3

Total: 10 credits

Spring, Year Two (M.S. students)

Course Name(s) and Number(s)	**Credits**
BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
BISC 869 - Master's thesis (research, in thesis/dissertation laboratory)	6
From elective list	3

Total: 10 credits

Electives

All students also are required to complete one elective from the approved list. Choice of elective should be made with approval of the student's research advisor.

BISC 605 - Advanced Mammalian Physiology

BISC 612 - Advanced Cell Biology

BISC 615 - Vertebrate Developmental Biology

BISC 625 - Cancer Biology

BISC 639 - Developmental Neurobiology

BISC 645 - Bacterial Evolution

BISC 656 - Evolutionary Genetics

BISC 671 - Cellular and Molecular Immunology (4 credits)

BISC 679 - Virology

BISC 693 - Human Genetics

BISC 806 – Advances in Cell and Organ Systems

ANSC 644 - Bioinformatics

CHEM 645 - Proteins, Structure and Function

CHEM 646 - DNA-Protein Interactions

CHEM 648 - Membrane Biochemistry

ELEG 673 - Signal Processing in Neural Systems

PLSC 635 - Plant Developmental Biology

PLSC 646 - Plant Cell Biology

Masters students must complete 24 credits of course work/research credit in addition to 6 credits of BISC 869 - Master's Thesis, prior to public defense of the research based Master's thesis.

Doctoral students must pass a qualifying examination in order to advance to candidacy for the Ph.D. degree.

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 Track requirements with the approval of the Track coordinator.

Other courses in addition to those listed above may be taken upon the advice of the student's advisor and thesis/dissertation committee, but these will not substitute for approved electives

Doctoral Year Three - until successful completion of qualifying exam

Course Name(s) and Number(s)	**Credits**
BISC 964 - Pre-candidacy Study	6
BISC 827 - Graduate Research Seminar	1

Total: 7 credits

After completion of qualifying exam by Doctoral students

Course Name(s) and Number(s)	Credits
BISC 969 - Doctoral Dissertation	9
BISC 827 - Graduate Research Seminar	1

Total: 10 credits

The Preliminary Examination

Graduate students in the Molecular Biology and Genetics Track 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 preliminary examination will be administered to all graduate students in the Track at the end of their first year of study.

In order to be eligible to take the preliminary exam, students must have completed first year core courses (CHEM6411 if needed, BISC602, and BISC654) with a grade of B or better. In all cases, the student is expected to correct all deficiencies in their performance in the first year curriculum by the end of the semester after the deficiency occurred but no later than the end of their third semester in the program. If the applicable course is not offered, a suitable substitute will be determined by the Track coordinator. Failure to obtain a B or better in a required course in the second attempt will make the student subject to dismissal from the graduate program. Students are expected to take the preliminary exam within six weeks after the first year curriculum has been successfully completed. If the student fails to complete the preliminary 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 Track faculty from which they must choose one set as the basis for their oral examination. These papers will be available at least six weeks before the exam, usually no later than May 1 [for students admitted in the summer or fall], so that the exam can be administered the second or third week of June. Students admitted in the Spring will usually have paper sets available by December 10 so that the exam can be administered in late January. Four weeks prior to the exam, the student should inform the Track coordinator of the chosen paper set and arrange the time of the exam. Prior to the exam, the student should prepare transparencies 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 four to six Track faculty on his/her comprehension of all aspects of the paper including background and related information. Students present a 10 minute synopsis of the primary paper, then the examination committee will ask questions pertaining to the paper's background material, methodology, experimental results and their significance, the article's overall significance to the field as well as the topics found in the list of core competencies. It therefore is imperative that the student searches and reads the literature for background and related information. While a good starting point is the bibliography at the end of the chosen paper set, it is likely that other primary literature sources will need to be consulted. Prior to the exam, students are encouraged to contact faculty to discuss the topics they are responsible for and to clarify difficult concepts.

Grading

After the oral examination, the examination committee will determine an appropriate grade. Four grades are possible at the initial exam: unconditional pass, conditional pass, re-examination or failure. If the student receives an unconditional pass, the exam was completed satisfactorily and no conditions are applied. In a 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 both the Biology Graduate Program Director and the Track Coordinator so that the grade can be changed officially. If the student receives a re-examination, the student's performance was unsatisfactory and the exam should be repeated within three months, but no later than six months after the initial examination. Only one retake will be permitted. This

would normally be prior to the start of the fall semester for June examinations, and during Spring break for January examinations. If the student receives a failure, the student's performance strongly indicated an inability to complete an independent research project and the student will be terminated from the Molecular Biology and Genetics Track without the possibility of a retest. If the student does not perform satisfactorily in a re-examination, the student will be terminated from the Molecular Biology and Genetics Track.

Once the student passes the preliminary examination, he/she 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 write and defend a research proposal;

an understanding of the research area in which he or she is interested;

the ability to formulate a research problem and to comprehend its significance; and,

the ability to design appropriate experimental approaches to solve the problem.

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 he or she 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.

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 a format similar to an NIH grant proposal 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 (see below).

The Research Proposal must be double-spaced and should include:

Specific Aims: State concisely and realistically what the research is intended to accomplish and what hypothesis is to be tested. 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 relating the specific aims to longer term objectives. Four to eight 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. Fifteen to twenty 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.

The Proposal also may contain a concise Preliminary Results section. However, the candidacy examination is not meant to be a defense of the student's previous laboratory work, but rather it should be an evaluation of the student's ability to construct a hypothesis and to design the means by which to test it.

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. 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 four 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.

Prior to the exam, the student should meet with each committee member to clarify which topics that member feels are relevant for the background knowledge portion of the exam. 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 during which the committee will not ask questions except to clarify very specific issues (graph axes, incubation times, etc.). 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 their project.

If the student receives a grade of unconditional pass, the student will be admitted into candidacy and should arrange for the appropriate paperwork to be filed with the graduate school. If the student receives a grade of conditional pass, deficiencies were found in the student's preparation that need to be rectified by completion of the "condition(s)" before the student is admitted into candidacy. The student is responsible for informing the graduate program director when any such conditions are fulfilled so that the student can be admitted into candidacy. If the student receives a re-examination, deficiencies in the written proposal and/or the student's scientific background will need to be corrected and the defense repeated. Only one reexamination will be permitted. If the student fails the qualifying exam on the first or second attempt, the student may be either recommended

for a terminal Master's degree or for termination from the Ph.D. program by the examining committee.

Chemistry-Biology Interface Track Policy and Curriculum

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 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 and molecular biology upon admittance to the program since these fields underpin the training provided in this track. These competencies can be demonstrated by superior performance in biochemistry and molecular biology courses from another institution. Acceptance of these courses from other institutions is subject to approval by the Track Coordinator. CHEM 641 and CHEM 642 can be used to provide competency in biochemistry and molecular biology, respectively.

Fall, Year One

Course Name(s) and Number(s)	**Credits**
BISC 631 - Practice of Science	3
CHEM 641 - Biochemistry*	3
BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
CHEM 667 - interface research: CHEM/BIOL**	3
Total: 10 credits	

Winter, Year One

Tutorial**

Spring, Year One

Course Name(s) and Number(s)	**Credits**
One of the following literature-based graduate courses: BISC 612 - Advanced Cell Biology BISC 654 - Biochemical Genetics BISC 656 - Evolutionary Genetics BISC 679 - Virology CHEM 624 - Principles of Mass Spectrometry CHEM 646 (667-011) - DNA: Protein Interactions	3
CHEM 642 - Biochemistry*	3
BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
Total: 7 credits	

*Or a course from the elective list below if the student already has demonstrated competency.
**At least one tutorial should be done in the lab of a faculty member whose primary appointment is outside the department of Biological Sciences.

Summer, Year one
June

- Preliminary examination (see below)

July and August

- BISC 868 - Research in the thesis/dissertation laboratory (6 credits)
- Identification of Advisory Committee and first committee meeting***

***The Advisory Committee will be constituted as described for the overall Ph.D. graduate program in Biological Sciences, with the additional stipulation that at least three members of the committee must be Chemistry-Biology interface faculty. This can include the student's advisor.

Fall, Year Two

Course Name(s) and Number(s)	**Credits**
BISC 665 - Advanced Molecular Biology and Genetics	3
BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
BISC 868 - Research, in thesis/dissertation laboratory	6

Total: 10 credits

Spring, Year Two

Course Name(s) and Number(s)	**Credits**
Elective chosen from list below	3
BISC 827 - Graduate Research Seminar, course in oral presentation skills	1
BISC 868 - Research, in dissertation laboratory	6

Total: 10 credits

Electives: Choice of electives should be made with approval of the student's thesis advisor.

- BISC 602 - Molecular Biology of Animal Cells
- BISC 605 - Advanced Mammalian Physiology
- BISC 612 - Advanced Cell Biology
- BISC 615 - Vertebrate Developmental Biology
- BISC 639 - Developmental Neurobiology
- BISC 654 - Biochemical Genetics
- BISC 656 - Evolutionary Genetics
- BISC 671 - Cellular and Molecular Immunology
- BISC 679 - Virology
- BISC 693 - Human Genetics
- BISC 806 – Advances in Cell and Organ Systems
- ANSC 644 - Bioinformatics
- CHEM 624 - Principles of Mass Spectrometry
- CHEM 643 - Intermediary metabolism
- CHEM 645 - Protein: Structure and Function
- CHEM 646 - (667-011) DNA: Protein Interactions
- CHEM 647 - Biochemical Evolution
- CHEM 648 - Membrane Biochemistry
- CHEM 649 - (667-012) Molecular Biophysics
- CHEM 667 - DNA-Protein Interactions
- CHEM 667 - Bioorganic Chemistry and Chemical Biology
- CHEM 667 - Mechanisms of Enzyme Catalysis
- CHEM 830 - Peptide Chemistry
- ELEG 673 - Signal Processing in Neural Systems
- PLSC 635 - Plant Developmental Biology
- PLSC 646 - Plant Cell Biology

- PLSC 666 - Plant Physiology
- PLSC 804 - Plant Molecular Biology

If any graduate courses equivalent to those listed above have been taken in previous graduate degree programs and have been accepted as gradaute level transfer credit by the University, the transferred courses may be used to satisfy the Track requirements with the approval of the Track Coordinator.
Other courses in addition to those listed above may be taken upon the advice of the student's advisor and thesis/dissertation committee.

Year Three - until successful completion of qualifying exam

Course Name(s) and Number(s)	**Credits**
BISC 964 - Pre-candidacy Study	6
BISC 827 - Graduate Research Seminar	1
Total: 7 credits	

After completion of qualifying exam

Course Name(s) and Number(s)	**Credits**
BISC 969 - Doctoral Dissertation	9
BISC 827 - Graduate Research Seminar	1
Total: 10 credits	

Doctoral students must complete 2 semesters of teaching assistantship to enhance their oral presentation skills. It is recommended that this requirement be fulfilled during the second or third year.

Doctoral students must pass a qualifying examination in order to advance to candidacy for the Ph.D. degree.

The Preliminary Examination

Graduate students in the Chemistry-Biology Interface Track are expected to possess a fundamental body of knowledge in biochemistry equivalent to CHEM 641 and molecular/cellular biology equivalent to BISC 401 and CHEM 642, and the ability to critically analyze scientific literature. To ensure that this is the case, an oral preliminary examination will be administered to all graduate students in the Track at the end of their first year of study.

In order to be eligible to take the preliminary exam, students must have completed first year core courses (CHEM641 and CHEM642, if needed) with a grade of B or better. In all cases, the student is expected to correct all deficiencies in their performance in the first year curriculum by the end of the semester after the deficiency occurred, but no later than the end of their third semester in the program. If the applicable course is not offered, a suitable substitute will be determined by the Track coordinator. Failure to obtain a B or better in a required course in the second attempt will result in termination from the Track. Students are expected to take the preliminary exam within six weeks after the first year curriculum has been successfully completed. If the student fails to complete the preliminary exam by this time, the student with be terminated from the Track.

Procedure

Students will be provided with at least four sets of papers from the primary literature selected by Track faculty from which they must choose one set as the basis for their oral examination. These papers will be available at least six weeks before the exam, usually no later than May 1, so that the exam can be administered the second or third week of June. Four weeks prior to the exam, the student should inform the Track coordinator of the chosen paper set and arrange the time of the exam. Prior to the exam, the student should prepare transparencies or computer graphics of all of the figures and tables presented in the papers so that they will be available for discussion during the exam.

During the exam, the student will be tested by a committee of four to six Track faculty members on his/her comprehension of all aspects of the paper including background and related information. Students present a 10 minute synopsis of the primary paper, then the examination committee will ask questions pertaining to background material, methodology, experimental results and their significance, as well as the article's overall significance to the field. It therefore is imperative that the student searches and reads the literature for background and related information. While a good starting point is the bibliography at the end of the chosen paper set, it is likely that other primary literature sources will need to be consulted. Prior to the exam, students are encouraged to contact faculty to discuss the topics they are responsible for and to clarify difficult concepts.

Grading

After the oral examination, the examination committee will determine an appropriate grade. Four grades are possible at the initial exam: unconditional pass, conditional pass, re-examination or failure. If the student receives an unconditional pass, the exam was completed satisfactorily and no conditions are applied. In a 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 both the Biology Graduate Program Director and the Track Coordinator so that the grade can be changed officially. If the student receives a re-examination, the student's performance was unsatisfactory and the exam must be repeated preferably within three months, but no later than six months after the initial examination. Only one retake will be permitted. If the student receives a failure, the student's performance strongly indicated an inability to complete an independent research project and the student will be terminated from the Chemistry-Biology Interface Track without the possibility of a retest. If the student does not perform satisfactorily in a re-examination, the student will be terminated from the Chemistry-Biology Interface Track.

Once the student passes the preliminary examination, he/she 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 write and defend a research proposal;
- an understanding of the research area in which he or she is interested;

- the ability to formulate a research problem and to comprehend its significance; and,

- the ability to design appropriate experimental approaches to solve the problem.

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 he or she 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.

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 a format similar to an NIH grant proposal 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 (see below).

The Research Proposal must be double-spaced and should include:

- Specific Aims: State concisely and realistically what the research is intended to accomplish and what hypothesis is to be tested. 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 relating the specific aims to longer term objectives. Four to eight 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. Fifteen to twenty 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 below:

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

The Proposal also may contain a concise Preliminary Results section. However, the candidacy examination is not meant to be a defense of the student's previous laboratory work, but rather it should be an evaluation of the student's ability to construct a hypothesis and to design the means by which to test it.

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**. 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 four 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.

Prior to the exam, the student should meet with each committee member to clarify which topics that member feels are relevant for the background knowledge portion of the exam. 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 during which the committee will not ask questions except to clarify very specific issues (graph axes, incubation times, etc.). 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 their project.

If the student receives a grade of **unconditional pass**, the student will be admitted into candidacy and should arrange for the appropriate paperwork to be filed with the graduate school. If the student receives a grade of **conditional pass**, deficiencies were found in the student's preparation that need to be rectified by completion of the "condition(s)" before the student is admitted into candidacy. The student is responsible for informing the Graduate Program Director when any such conditions are fulfilled so that the student can be admitted into candidacy. If the student receives a **re-examination**, deficiencies in the written proposal and/or the student's scientific background will need to be corrected and the defense repeated. Only one reexamination will be permitted. If the student **fails** the qualifying exam on the first or second attempt, the student either may be recommended for a terminal Master's degree outside of the Chemistry-Biology Interface Track or for termination from the Ph.D. program by the examining committee.