

Graduate Concentration in Cell and Organ Systems: Ph.D. 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 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 Cell and Organ Systems. All students are expected to have basic competency in general physiology and cell biology upon admittance to the concentration since these fields underpin the training provided.

The Cell and Organ Systems Graduate Concentration 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 concentration 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. The Ph.D. degree program will emphasize the development and critical defense of an independent research project (dissertation).

Required Courses:

BISC 605 - Advanced Mammalian Physiology 34

BISC 612 - Advanced Cell Biology 3

BISC 827 - Graduate Research Seminar¹ 1 credit every semester

BISC 864 - Laboratory Tutorial² 4

Notes:

1. 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.

2. For the Ph.D. program, BISC 864 credit will include, during the first year, two, two-credit Laboratory Tutorials or rotations in 2 different research labs (one of which will ultimately be chosen as the primary research lab). During winter term of the first year, Ph.D. students are expected to devote full time effort to a laboratory tutorial. Registration for this is during the spring semester.

~~Students wishing to enter this concentration are expected to have some background (at the undergraduate or graduate level) in general physiology, cell biology, biochemistry and genetics/evolutionary biology.~~

The requirements for the Ph.D. Degree are as follows:

1. 16 credit hours of selected graduate level coursework
2. a series of 2 Laboratory Tutorials or rotations (BISC 864)
3. at least 2 semesters of teaching experience (as a Teaching Assistant)
4. successful completion of a Graduate Preliminary Exam
5. research on a significant scientific problem
6. Ph.D. Candidacy Exam
7. a Dissertation Defense

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 and Number	Credits
BISC 605—Advanced Mammalian Physiology (core)	3
BISC 827—Graduate Seminar (core) ¹	1
Teaching Assistantship ²	0
BISC 864—Research Tutorial ³	2

Winter Session⁴

Spring Semester	
Course Name and Number	Credits
BISC 612—Advanced Cell Biology (core)	3
BISC 827—Graduate Seminar (core)	1
BISC 864—Research (Laboratory Tutorial)	2
Teaching Assistantship	0
BISC 868—Research ⁵	Variable

Summer Session	
Course Name and Number	Credits
Graduate Preliminary Exam	-
BISC 868—Research ⁶	Variable

Year Two:

Fall Semester	
Course Name and Number	Credits
BISC 6XX—Elective (core)	3
BISC 827—Graduate Seminar (core)	1
Teaching Assistantship	0
BISC 964 ⁶	Variable

Spring Semester	
Course Name and Number	Credits
BISC 806—Current Topics in Cell and Organ Systems, or	3
BISC 833—Special Topics in Biology (core)	
BISC 827—Graduate Seminar (core)	1
Teaching Assistantship	0
BISC 964—Research	Variable

Year Three:

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~~Until successful completion of qualifying exam~~

Course Name and Number	Credits
BISC 964—Pre-candidacy Study	6
BISC 827—Graduate Research Seminar	1

~~Total: 7 credits~~

~~After completion of qualifying exam~~

Course Name and Number	Credits
BISC 969—Doctoral Dissertation	9
BISC 827—Graduate Research Seminar	1

~~Total: 10 credits~~

Notes

- ~~1. 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.~~
- ~~2. For Ph.D. students, Teaching Assistantship will be awarded to (usually) new graduate students as part of their requirement to gain teaching experience. All Ph.D. student must serve as teaching assistants at least two semesters but under usual circumstances, no more than 4 semesters (two years) will be supported on TA stipends. 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, two, two-credit Laboratory Tutorials or rotations in 2 different research labs (one of which will ultimately be chosen as the primary research lab).~~
- ~~4. Ph.D. students are expected to devote full time effort during winter term of the first year in a laboratory tutorial that they will register for during spring.~~
- ~~5. BISC 868 credits during the following spring semester will be considered research credit, assigned by the student's primary research advisor.~~
- ~~6. Students are expected to devote summer session after the first year to full time research work towards the dissertation after completion of the preliminary examination.~~

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.~~

Graduate Electives

~~The following list of graduate courses are those that can be used as Electives in the Cell and Organ Systems Concentration. However, other courses, including selected courses from other departments may also be included, with approval of the student's 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 Concentration requirements with the approval of the Concentration 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—Ichthyology~~

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- ~~BISC 631 - The Practice of Science~~
- BISC 639 - Developmental Neurobiology
- ~~BISC 645 - Bacterial Evolution~~
- ~~BISC 646 - Plant Cell Biology~~
 - [BISC 643 - Biological Data Analysis](#)
 - [BISC 654- Biochemical Genetics](#)
- 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
- [BISC 690 - Fundamentals of Pharmacology](#)
- CHEM 641 - Biochemistry
- PLSC 635 - Plant Developmental Biology

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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.

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 M.S. 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).~~

The Comprehensive Examination

Graduate students in the Cell and Organ System concentration are expected to possess a fundamental body of knowledge in (see the core competency list <http://www.bio.udel.edu/graduate-concentration-cell-and-organ-systems-preliminary-exam-guidelines> for more details) as well as the ability to critically analyze scientific

literature. To ensure that this is the case, an oral comprehensive examination will be administered to all graduate students in the Concentration.

Graduate Preliminary Exam in the Cell and Organ Systems Concentration

All graduate students in the Cell and Organ Systems Concentration 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 comprehensive~~ exam, students must have completed first year core courses (BISC 605 and BISC 612) 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. 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 Concentration 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 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 be available for discussion during the exam.

During the exam, the student will be tested by a committee of four 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 as listed at <http://www.bio.udel.edu/graduate-concentration-cell-and-organ-systems-preliminary-exam-guideline>. 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.

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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.

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

The examining committee (4 faculty members appointed by the Concentration 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, by carefully reviewing the bibliography of the selected article and the core competency list of topics. 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)

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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 Concentration 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 Concentration and recommended to the Graduate affairs committee for dismissal from the graduate program. 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.

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.

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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

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must have at least four 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.

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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,

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conditional pass or failure. The student may not take the qualifying exam a third time.

- Failure. This outcome would indicate that 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

<u>Course Name and Number</u>	<u>Credits</u>
<u>BISC 605 - Advanced Mammalian Physiology</u>	<u>3</u>
<u>BISC 827 - Graduate Research Seminar</u>	<u>1</u>
<u>BISC 864 - Laboratory tutorial</u>	<u>2</u>
<u>Teaching assistantship, development of oral presentation and teaching skills</u>	<u>0</u>

Total: 6.7 credits

Winter Session

- Second laboratory tutorial

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Spring Semester

<u>Course Name and Number</u>	<u>Credits</u>
<u>BISC 612 - Advanced Cell Biology</u>	<u>3</u>
<u>BISC 827 - Graduate Research Seminar</u>	<u>1</u>
<u>BISC 864 - Laboratory tutorial (registration for winter session tutorial)</u>	<u>2</u>
<u>BISC 868 - Research in the laboratory of chosen dissertation advisor</u>	<u>2</u>
<u>Teaching assistantship, development of oral presentation and teaching skills</u>	<u>0</u>

Total: 8 credits

Summer Session

- early June
 - Comprehensive examination

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- 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

<u>Course Name and Number</u>	<u>Credits</u>
<u>Elective</u>	<u>3</u>
<u>BISC 827 - Graduate Research Seminar</u>	<u>1</u>
<u>Research in dissertation laboratory</u> (<u>BISC 868 for students who have unconditionally passed comprehensive exam</u> <u>or BISC 964 for students who have not unconditionally passed comprehensive exam</u>)	<u>4-6</u>

Total: 8-10 credits

Spring Semester

<u>Course Name and Number</u>	<u>Credits</u>
<u>Elective</u>	<u>3</u>
<u>BISC 827 - Graduate Research Seminar</u>	<u>1</u>
<u>BISC 964 - Research in dissertation laboratory</u>	<u>6</u>

Total: 10 credits

Years Three-Five:

Until successful completion of qualifying exam:

<u>Course Name and Number</u>	<u>Credits</u>
<u>BISC 964 - Pre-candidacy Study</u>	<u>6</u>
<u>BISC 827 - Graduate Research Seminar</u>	<u>1</u>

Total: 7 credits

After completion of qualifying exam:

<u>Course Name and Number</u>	<u>Credits</u>
<u>BISC 969 - Doctoral Dissertation</u>	<u>9</u>
<u>BISC 827 - Graduate Research Seminar</u>	<u>1</u>

Total: 10 credits

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

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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 Preliminary 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

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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.

Dissertation Defense

The 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 Dissertation Committee.