

# Ph.D. in Biology

## Course Requirements

### General Credit/Course Distribution

Three Biology Graduate Program Core Courses	9
Three Track Specific Core Courses	9
Two Semester Long Laboratory Rotations	6
Elective Courses (can be taken at Rutgers, RBHS, NJIT)	12
Total Required Research Credits	36
<b>Total Credits</b>	<b>72</b>

### Ph.D. in Biology (cell biology track)

<b>Required Courses</b>		
R120 560	College Teaching	3
BIOL 630	Critical Thinking for the Life Sciences	3
MATH 615	Approaches to Quantitative Analysis in the Life Sciences <sup>1</sup>	3
<b>Cell Biology Core Courses</b>		
R120 524	Cell Molec Dev	3
R120 515	Molecular Bio Of Eukaryotes	3
R160 581	Biochemistry	3
<b>Electives</b>		
Approved electives <sup>2</sup>		12
<b>Laboratory Rotations</b>		
R120 509 & R120 510	Adv Problems In Biology and Adv Prob In Biol	6
<b>Required Research</b>		
Research		36
<b>Total Credits</b>		<b>72</b>

<sup>1</sup> Equivalent course may be substituted if approved.

- <sup>2</sup> Elective course may be taken from offerings in the following graduate programs:
- Rutgers University, Newark -- Biology, Environmental Sciences, Integrative Neuroscience, and Chemistry
  - NJIT -- Applied Mathematics, Physics, Biomedical Engineering, and Computer Science
  - RBHS -- Program in Biomedical Sciences
  - Rutgers University, New Brunswick and Camden -- various programs

Prior to enrolling in courses offered by graduate programs outside of the Graduate Program in Biology, students must receive permission from the Graduate Standards Committee if they are pre-qualifiers or from the Program Director if they are post-qualifiers. This is accomplished by completion of the Graduate Transfer Credit Form. Whenever appropriate the student should consult with his/her thesis research advisor. Please check course catalogs and online schedule of classes for specific course offerings on a semester-by-semester basis.

### Ph.D. in Biology (ecology and evolution track)

<b>Required Courses</b>		
R120 560	College Teaching	3
BIOL 630	Critical Thinking for the Life Sciences	3
MATH 615	Approaches to Quantitative Analysis in the Life Sciences <sup>1</sup>	3
<b>Ecology and Evolution Core Courses</b>		
R120 523	Scale Of Biodiversity	3
BIOL 622	Evolution	3
R120 593	Physiological Ecol	3
<b>Electives</b>		
Approved electives <sup>2</sup>		12
<b>Laboratory Rotations</b>		

R120 509 & R120 510	Adv Problems In Biology and Adv Prob In Biol	6
<b>Required Research</b>		
Research		36
<b>Total Credits</b>		<b>72</b>

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## Ph.D. in Biology (computational neuroscience track)

<b>Required Courses</b>		
R120 560	College Teaching	3
BIOL 630	Critical Thinking for the Life Sciences	3
MATH 615	Approaches to Quantitative Analysis in the Life Sciences <sup>1</sup>	3
<b>Computational Neuroscience Core Courses</b>		
MATH 637	Foundations of Mathematical Biology	3
MATH 635	Analytical Computational Neuroscience	3
or MATH 636	Systems Computational Neuroscience	
BIOL 641	Systems Neuroscience	3
<b>Electives</b>		
Approved electives <sup>2</sup>		12
<b>Laboratory Rotations</b>		
R120 509 & R120 510	Adv Problems In Biology and Adv Prob In Biol	6
<b>Required Research</b>		
Research		36
<b>Total Credits</b>		<b>72</b>

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## Notes on Grade Requirements in Coursework

Students are expected to successfully complete all of the core and elective credits taken within the graduate program. Course work provides the formal foundation upon which a successful dissertation project and thesis defense is built.

To remain in good standing, a GPA of 3.0 or better must be maintained for all courses taken as part of the graduate course of study. Courses cannot be repeated in order to improve on poor performance. Furthermore, while in the program a student can receive grades of C or C+ in a maximum of two courses, only one of which may be in the six Program and Track Core courses. Receipt of a grade of F in any course-core or elective - will under normal circumstances result in dismissal from the program at the end of the academic year.

## Mentoring Laboratory

Incoming student will be assigned to a "mentor lab" during their first semester in the program. During this time, students are required to actively participate in lab meetings, journal clubs, and other general lab activities. Additionally, the student must participate in some "minimal form" of research work as determined by the faculty mentor. At the end of the semester, the student must submit a brief three page-maximum report on the research conducted and the mentor submits a Student Rotation/Mentoring Evaluation Form to the Graduate Standards Committee.

## Biology Colloquium

The biology colloquium is a combined seminar and reading course that provides students exposure to modern day research in areas representing the three tracks of the Ph.D program. Every student is required to attend the weekly colloquium seminars while he/she is matriculated in the Doctoral Program in Biology. Failure to meet this obligation (missing three or more colloquia) can result in loss of financial support and suspension from the Program.

## Laboratory Research Rotations

Laboratory rotations (Advanced Problems in Biology R120 509 Adv Problems In Biology, R120 510 Adv Prob In Biol) provide opportunities for laboratory research and independent study with graduate faculty members. Students are required to complete a minimum of two rotations; it is expected that one of the rotations will be completed in the laboratory where the student plans to complete his/her thesis work. Students start the first of two mandatory semester long laboratory rotations in the spring semester of the first year in the program. Typically rotations are completed in the spring and summer of the student's first year in the program.

Selection of laboratory rotation is done in consultation with the Graduate Standards Committee and the appropriate faculty member. The student must submit a Rotation Prospectus Form to the Graduate Standards Committee prior to the start of the rotation. Completion of the laboratory rotation requires the student to prepare a written report that is to be submitted within one month following the end of the rotation. The rotation advisor decides upon the format, content, and anticipated outcome of the rotation report. Additionally, at the end of the rotation the advisor submits a Student Rotation/Mentoring Evaluation Form to the Graduate Standards Committee.

The anticipated outcomes of the rotation include, but are not limited to, development of laboratory/field/computational research skills, development of analytical and critical thinking skills, appreciation of a specific research field, and identification of a prospective thesis research lab. Under extraordinary circumstances, the Graduate Standards Committee may approve a student's request to conduct a third rotation that must be completed in the fall semester of the second year in the program.

## Selection of Dissertation Lab

Following completion of all laboratory rotations, students must select a graduate faculty member who will serve as his/her primary advisor during the research phase of the doctoral program. This process is typically completed by the beginning of the second year in the program at which time the student will commence developing and accumulating preliminary data for his/her thesis dissertation project.

## Qualifying Examination

The qualifying exam will be administered by the Qualifying Examination Committee, which consists of three faculty members from the student's intended research track within the Graduate Program in Biology. A student's thesis advisor may not be a member of her/his Qualifying Examination Committee. The Qualifying Examination will be administered during the first two weeks of June. Examination dates will be posted on the department's Academic Calendar. Students take the examination at the end of their fourth semester in the program following successful completion of all core course requirements, successful completion of two rotations, and identification of the thesis advisor.

The Qualifying Examination will consist of written and oral components. Before beginning to write the detailed research proposal, the student sends a one-page summary of the specific aims to the Qualifying Exam Committee (this summary is to be submitted by April 1st at the latest). The committee must approve the proposal; the committee may offer general feedback on the scope of the project and suitability of the aims. There is no specific restriction on the subject of the qualifying exam proposal other than it must be original and the work product of the student. The proposal is the detailed description of a feasible research project, including specific aims, background and significance, and research design and methods (10,000 words maximum). A good format to follow is that of a pre- or post-doctoral grant application submitted to the National Science Foundation (specific format information is available in the program office). Preliminary data are NOT required as part of the proposal. The full proposal must be sent to each of the examiners at least 14 days before the date of the exam. Submitting a proposal that is too long or too late is unprofessional and runs the risk of non-acceptance and examination failure.

The Qualifying Exam Committee will review the written proposal for clarity of presentation, scientific soundness, and understanding of the hypothesis being tested. The student prepares an oral introduction and overview of the project that should last no more than 25 minutes. The examiners will interrupt with questions during the presentation, so the actual presentation component will take longer. The oral presentation generally takes the form of a PowerPoint presentation, but any format that effectively communicates the main ideas is acceptable, including overheads and writing on a board. While the written proposal is the main focus of the exam, students are expected to demonstrate substantial knowledge in the field of the proposal and in related scientific areas. For example, if the proposal was aimed at understanding information transfer along the pathway from retina to visual cortex

in the adult rodent, it would be fair the examiners to ask questions concerning the cell and the developmental biology of the pathway, the synaptic connectivity along the pathway, the general principles of synaptic physiology, and how it is studied.

The outcome of the examination must persuade the committee that the student has a solid comprehension of general principles and phenomena in the biological sciences and that he/she can reason through an experimental problem. Results of the examination will be reported on the Qualifying Examination Committee Report form and submitted to the Program Administrator. If a student does not pass the written and/or oral component of the qualifying examination, the student may be offered a second attempt to complete the exam. The reasons and recommendation for a second exam will be made available to the student via the Qualifying Examination Committee Report form. The second attempt at completion of the Qualifying Exam will take place six weeks after the initial exam date. Results of the second examination will be reported by completion submission of the Qualifying Examination Committee Report form. Failure to pass either the written or oral part of the qualifying examination on the second attempt will result in dismissal of the student from the program.

After successful completion of the Qualifying Examination, the student must submit to the Graduate Program Director either the Application for Admission to Candidacy for the Doctoral Degree (Rutgers matriculated students) or the Ph.D Examination Report Form (NJIT matriculated students) that was signed by all members of the Qualifying Examination Committee. After review and completion of the form by the Graduate Program Director, this application must be returned to the appropriate Office of the Graduate School Dean at Rutgers or the Office of Graduate Studies at NJIT.

## Thesis Prospectus and Dissertation Committee

Within six months of passing the Qualifying Examination, the student will prepare and submit a written thesis prospectus to her/his Dissertation Committee. The Dissertation Committee will be composed of the student's thesis advisor (who serves as committee chair), at least two other members of the Biology Graduate Faculty, and one member from outside the Rutgers\_NJIT scholarly community; the external member may not be a member of the Graduate Program in Biology, he/she shall have demonstrated research expertise in the general area of prospective dissertation project, and he/she shall have no vested interest in the outcome of the dissertation research. The outside committee member may be appointed at any time but no later than one year prior to the dissertation defense. The Dissertation Committee is the primary advisor group responsible for supervision and guidance of the student during the research phase of the dissertation. The Dissertation Committee serves as the examination committee for the dissertation defense.

To establish Dissertation Committee, the student and advisor must submit the Ph.D Dissertation Committee Appointment Report for approval from the Graduate Program Director. Students matriculated at NJIT are responsible for also completing the NJIT Ph.D Dissertation Committee Appointment Report and submitting this form to the NJIT Office of Graduate Studies; a copy is kept on file with the student's permanent record.

The written prospectus will follow the format of a NH or NSF postdoctoral fellowship application. The thesis prospectus meeting will determine the student's ability to conceive, design, and conduct the proposed research project. After completion of the Thesis Prospectus meeting, the outcome of the meeting must be recorded on the Dissertation Progress Report form and the completed form submitted to the Graduate Program Administrator for filing with the student's permanent record. Additionally for NJIT matriculated students, a Ph.D Proposal Defense Report must be completed; the signed original is returned to the NJIT Office of Graduate Studies and a copy is submitted to the Graduate Program Administrator.

During the course of the research thesis, the Dissertation Committee should regularly meet with the student (six month intervals is appropriate) to discuss research progress, experimental challenges, and potential changes to the original thesis prospectus. Meeting dates, recommendation, and outcomes will be recorded by the Thesis Advisor on the Dissertation Progress Report form and forwarded to the Program's Administrator for filing with the student's permanent record.

In the event a student does not successfully complete his/her thesis prospectus in a timely manner, the Standards Committee will convene a meeting with the student and his/her mentor to review the student's progress and to prepare a plan of action for completion of the prospectus requirement. A record of this meeting will be detailed on the Dissertation Progress Report form that becomes part of the student's permanent file.

Failure to comply with the above timelines and procedures can result in loss of departmental financial support and dismissal from the program.

## Dissertation Defense

Approximately six months prior to the Dissertation Defense, the Dissertation Committee will convene a meeting with the Ph.D candidate for a final progress report to the committee. The meeting should be attended by all members of the Dissertation Committee (internal and external), at which time the committee will evaluate if sufficient progress has been made to warrant the final preparation of the thesis and to establish an approximate timetable for completion of the thesis. The outcome of this meeting is recorded and reported on the Dissertation Progress Report form.

The completed dissertation must be submitted to all members the final Dissertation Committee at least one month prior to the scheduled Dissertation Defense. The Dean of the Rutgers-Newark and NJIT Graduate Schools, Program Director, and Department Chairs must be invited to attend and the event must be publicized and open to anyone wishing to attend. The public defense of the dissertation is followed by an oral examination by the Dissertation Committee. Following completion of the Dissertation Defense the student's advisor must complete and file a Defence Report form with the Graduate Program Administrator.

Upon successful defense of the dissertation, Rutgers matriculated students must retrieve the Application for Admission to Candidacy for the Doctoral Degree previously submitted to the Office of the Dean of Graduate School-Newark and present this to the Chair of the Dissertation Committee. The Dissertation Committee must sign the retrieved form, and the Program Director must sign Part II of the Application for Admission to Candidacy for the Doctoral Degree. Students matriculated at NJIT are required to file the Ph.D Dissertation Defense Report form, which must be signed by all Dissertation

Committee member, the Graduate Program Director and the Department Chairman before returning the original to the NJIT Office of Graduate Studies; a copy is forwarded to the Graduate Program Administrator. The student should consult with the appropriate Office of the Dean well in advance of his or her anticipated completion date regarding submission deadlines for the Diploma Application, submission requirements for the dissertation, payment of the microfilming fee, and other matters.

In the event that the student fails to successfully defend the dissertation, one additional Dissertation Defense may be attempted. Reasons for the failure will be provided on the Ph.D. Dissertation Defense Report form. Failure on the second attempt will result in dismissal from the program. Appeals by the student should be directed to the Academic Standing and Student Review Committee of the Graduate School.

The Rutgers Graduate School has a seven-year limit for full time students for attaining a doctoral degree. The NJIT Office of Graduate Studies allows no more than six years of registration for doctoral dissertation.

## Assistantships and Fellowships

Full-time matriculated students may be offered, on a competitive basis, assistantships or fellowships. These are academic or calendar year awards and are renewable on a yearly basis, usually for not longer than a total of five years. Students are encouraged to apply to national, regional, and state level funding agencies to obtain grant support to their intended research program.

## Teaching Duties

Students awarded teaching assistantships generally will be given teaching assignments each semester. Failure to perform adequately as a teaching assistant will result in revocation of the assistantship by the Program Director.

Students awarded graduate assistantship, research assistantship, or fellowships through the Department or who are supported by research grants or external fellowships will be expected to serve a total of not less than two semesters for a total of six to nine contact hours as teaching assistants, except in instances in which the assistantship or fellowship explicitly requires that the student not engage in any teaching activities. The Department Chair makes teaching assignments. Students awarded assistantships or fellowships are not permitted to hold employment outside the University. Failure to comply with this regulation will result in immediate revocation of the assistantship or fellowship.

## Research Project Location

All thesis research must be performed on site with the student's advisor in University facilities. The term "on site" includes appropriate venues such as, but not limited to, field sites, research stations, museums, aquaria and other such locations.

## Exceptions to Regulations

Exceptions to the foreign regulations may be granted by the Program Director, after consultation with the Admissions Committee and the Graduate Standards Committee, only in extremely unusual circumstances and only after rigorous justifications is presented in writing to the Program Directors.

Applications for performing research off-campus must include a detailed proposal for the research and the special facilities required for the project. A student may not register for "Matriculation Continued" unless he/she has been admitted to candidacy and has completed all coursework requirements (36 credits), rotations, and thesis prospectus,

## General Notes on Curriculum

Although the Program has three tracks and most students are likely to choose one track in which to concentrate, the Ph.D. program recognizes that some students may wish to establish an individualized course of study intermediate between the tracks. The individualized course of study must be developed in consultation with the student's major advisor and the Standards Committee with written approval of the Program Director.

## Academic Integrity and Scholarly Ethics

All students, faculty and staff associated with the Graduate Program in Biology are expected to adhere to the highest standards of academic integrity and scholarly ethics. As a guide to academic integrity and scholarly ethics please refer to the following sites:

<http://academicintegrity.rutgers.edu/academic-integrity-at-rutgers>

<http://integrity.njit.edu>

<http://uhr.rutgers.edu/ethics/>

## Lecture Outline

There will be 4 lecture exams ( a test will follow sections I-IV).

**I. Test #1:** The basis of cell structure and the structure and function of proteins, DNA and chromosomes will be discussed. Emphasis will be placed on the structure of DNA as it relates to replication, repair and recombination. **Chapters 1 & 4-6.**

**II. Test #2:** The regulation of transcription and translation in both prokaryotes and eukaryotes will be discussed with emphasis placed on laboratory techniques such as DNA cloning and manipulation will be discussed. **Chapters 7-8 & 10.**

**III. Test #3:** The structure of the plasma membrane and its use in both intercellular and intracellular transport will be discussed. **Chapters 11-12 & 15.**

**IV. Test #4:** The use of plasma membrane and the cytoskeleton in cell communication and cell division will be discussed. The molecular regulation of cell division and errors in cell division will also be covered. **Chapters 16-18 & 20.**

## Laboratory Outline

1. Laboratories will be completed and handed in the day they are complete in their entirety.
2. Labs are found in your lab manual and should be read in time for the lab.
3. Students may work in groups of 2-3 and should remain lab partners for the semester, as you will be sharing lab equipment.
4. The following labs will be covered during this semester (see calendar)
  - a. Protein Purification
  - b. Isolation of DNA from your cells and the Polymerase Chain Reaction
  - c. Analysis of your PCR reactions
  - d. Isolation and analysis of proteins from cells
  - e. Western Blotting
  - f. Cell Transformation
  - g. Analysis of Cell Transportation
  - h. Cell structure and communication
  - i. Analysis of common mutations in cancer cells
  - j. Capstone Lab: Restriction digests