



Handbook for the Graduate Program in Quantitative Biomedicine

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The graduate program in Quantitative Biomedicine is an interdisciplinary program designed for graduate students who wish to embrace the knowledge and quantitative tools of chemistry, physics, mathematics, computational sciences, engineering, and/or statistics to tackle complex, unsolved biological problems. Many of our students have an interest in biomedicine, a rapidly evolving area of excitement at Rutgers, although this is not a required area of focus.

The Quantitative Biomedicine Graduate Program is for students interested in interdisciplinary research, taking advantage of powerful quantitative tool to solve challenging problems in biology and medicine. Our students come from diverse backgrounds and have comparably diverse interests. Thus, the program is designed to individually guide students in customizing their coursework and research to best fit their interests.

Students may work either toward a Ph.D. within this program (with M.S. and/or M.Phil. degree(s) as possibilities along the way) or a joint Ph.D. in combination with one of many partnering graduate programs [e.g., Chemistry and Chemical Biology; Mathematics; Physics; Molecular Biosciences (Microbiology & Molecular Genetics; Biochemistry; Cell & Developmental Biology; Cellular &

Molecular Pharmacology; Physiology & Integrative Biology; Medicine; and Neuroscience); Biomedical Engineering; Electrical and Computer Engineering; Computer Science; Materials Science; and Ecology and Evolution]. Students making satisfactory progress can anticipate full funding with benefits until the Ph.D. is awarded.

This handbook is intended to serve as a resource for students and faculty of the graduate program in Quantitative Biomedicine. It defines the policies and procedures of the program and provides a timeline that covers all aspects of a student's graduate career from orientation through the thesis defense.

Additional sources of information:

Institute for Quantitative Biomedicine: www.iqb.rutgers.edu

Graduate School – New Brunswick: <http://gsnb.rutgers.edu>

Applying for Admission to Graduate Study at Rutgers: <http://gradstudy.rutgers.edu/>

Graduate Study at Rutgers:

http://catalogs.rutgers.edu/generated/nb-grad_current/pg102.html

University Schedule of Classes: <http://sis.rutgers.edu/soc/>

Course registration: Info: <http://nbregistrar.rutgers.edu/grad/index.htm>

Registration: <https://sims.rutgers.edu/webreg/>

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I. Rutgers Requirements for Ph.D. and Master's Degrees

(Further detailed in the Rutgers Catalog: <https://catalogs.rutgers.edu>)

A. Rutgers Ph.D. Requirements

Years: ≥3 yrs full-time effort required

Credits: ≥72 billable credits (i.e., course, rotation, and research credits) are required of which:

≥24 are research credits

≤12 are from undergraduate course credits

≤24 are transfer credits; must be ≤50% of total course credits and only if student has at least 12 credits as a Rutgers grad student

[The 6 credits associated with TAs, Gas, and GFs are considered e-credits and have no value as billable credits.]

Maximum # course/rotation/research credits/semester: 10 (though one may be able to obtain special permission to take an additional 1-2 credits for courses/rotations)

Minimum # credits/semester:

International students:

Pre-Admission to Candidacy Exam and before taking ≥24 research credits:

≥9 billable credits (Full-time)

Post-passing the Admission to Candidacy Exam and after taking ≥24 research credits:

≥1 billable credit

These students must fill out a Reduced Course Load form if taking <3 billable credits as a TA or GA and <9 billable credits as a GF.

Domestic students:

Pre-Admission to Candidacy and before taking ≥24 research credits:

If a student is a TA, GA, or GF: ≥1 billable credit

If a student is not a TA, GA, or GF (i.e., if a student is non-funded): ≥0 billable credits [or ≥1 billable credits if the student has a prior student loan(s) and wishes to defer payment toward the loan(s)].

S/he must fill out a Request for Health Insurance for Graduate PT Students Considered FT form to be eligible for health insurance and access to the student health centers.

If a student voluntarily takes a leave for one or more semesters of her/his program: ≥0 billable credits

S/he must fill out an Application for Readmission form.

If a student is forced to discontinue her/his coursework and/or research for 1-2 semesters (pre-Admission to Candidacy only): ≥ 0 billable credits (or ≥ 1 billable credits if the student has a prior student loan(s) and wishes to defer payment toward the loan(s). S/he must register for Matriculation Continued if signing up for 0 credits.

Post-passing the Admission to Candidacy Exam and after taking ≥ 24 research credits:

If a student is a TA, GA, or GF: ≥ 1 billable credit (unless s/he will be earning her/his degree in October, in which case there is no need to register in the last Fall semester; however, it is important to note that health insurance will end in August).

If a student is not a TA, GA, or GF (i.e., if a student is non-funded): ≥ 0 billable credits [or ≥ 1 billable credits if the student has a prior student loan(s) and wishes to defer payment toward the loan(s)].

S/he must fill out a Request for Health Insurance for Graduate PT Students Considered FT form to be eligible for health insurance and access to the student health centers.

If a student voluntarily takes a leave for one or more semesters of her/his program, s/he must fill out both an Application for Readmission form and a Restoration of Active Status form.

No more than 9 credits with grades of C or C+ will be accepted toward a Ph.D.

Transfer of credits:

Must be in field of study

Must be within last 6 yrs (or with the addition of a letter from the Graduate Program Director indicating your current level of information and that the course material is still current)

Can only be transferred after obtaining ≥ 12 course credits at Rutgers
 ≤ 1 year of coursework (i.e., 24 credits) allowed

$\geq B$'s only

$\leq 50\%$ of total course credits can be transferred

≤ 12 credits can be from undergraduate courses (taken while in grad school)
 provided these courses include "extra work" or get special approval

Dollar-saving and credit-wise notes about billable credits:

To reach the number of 72 billable credits required toward earning a

Ph.D., **pay attention** to this number from the early stages of graduate study. Billable credits include course, rotation, and/or research credits. There are several ways to maximize this number without any added expenses to the P.I.

1. **When TA'ing:**

TA's are entitled to 12 billable credits/semester (paid for by the State; special permission is required to take additional credits, with a cap at 16 credits). If they aren't all used during the semester, up to 4 of these credits/semester can be requested for the summer. (To do so, **the department in which the TA'ing is being done must be asked for a summer tuition remission card for the credits to be assigned.**)

2. **When taking ≥ 12 course credits:**

When taking ≥ 12 course credits, students are entitled to register for up to **4 free research credits** at no additional cost.

3. **When on certain graduate fellowships:**

Certain fellowships (such as GAANNs) entitle students to 12 billable credits/semester. This is not a general rule, however, so **be sure to ask about this so the maximum number of credits can be assigned.**

Qualifying Exam/Committee:

The qualifying exam should be taken as soon as the student has finished most of their course requirements. **Note: QB has additional requirements for this.**

Must be ≤ 4 yrs after start

Must be ≥ 2 semesters before defense

Committee must have ≥ 4 members: advisor + 2 graduate program faculty + 1 outside faculty member

May be written, oral, or both

Requires Ph.D. candidacy form

Thesis Preparation and Defense:

Barbara Sirman is the Sr. Administrator for Degree Certification and can answer any questions: 848-932-8122; sirman@grad.rutgers.edu

Must be registered for courses and/or research

Must use [Style Guide for Thesis and Dissertation Preparation](#)

Student files a diploma application through registrar's website: (detailed at URL above; specific date depends on year)

For an October-dated degree: ~October 1

For a January-dated degree: ~January 2

For a May-dated degree: ~April 1

Student picks up their Candidacy Form from Grad School and resubmits:

For an October-dated degree: ~October 1

For a January-dated degree: ~January 2

For a May-dated degree: ~April 15

Dissertation workshops are available

Every thesis must be filed electronically with the Graduate School of New Brunswick and may be filed electronically with UMI ProQuest of Ann Arbor, Michigan

Important Notes:

1. Electronic filing of a thesis constitutes a **publication**. Thus, it is likely to be wise to embargo one's thesis publication before publishing in journals, most of which won't publish data that has been previously published. You may embargo your thesis for a period of two years post-graduation.
2. Every time you publish—whether in a scientific journal or thesis archive—you agree to specific copyright and contract laws. These might disallow you from publishing a “second” time (*i.e.*, in a journal). Have the corresponding author make sure there is a statement (provided by the publishing company or added by the corresponding author) that ensures that you may include the publication in your thesis. The Rutgers expert on this is Janice Pilch, a copyright and licensing librarian (janice.pilch@rutgers.edu).
3. When using journal publications in one's thesis, the student needs to remember that s/he is not the sole author, so proper citation, and sometimes permission, is needed; contributions by each author need to be clarified and acknowledged.

B. Rutgers Master's Degree Requirements

Years: ≥1 yr of advanced academic study

Credits: ≥30 billable credits are required

Plan A: Thesis Masters: ≥12 course credits, must be at graduate level (500's and 600's); 6-12 research credits allowed

Plan B: Non-Thesis Master's: ≥30 course credits (≥18 of which must be at graduate level: 500's and 600's)

Transfer of credits:

≤40% credits may be transferred

≥B's only

Thesis and Non-Thesis Options/Committee:

Student can opt to write a thesis or to graduate without writing a thesis

Supervision: Student should be advised by the graduate program director, a

committee director, and professor supervising his/her courses
 Students must have ≥ 3 members or associate members in their graduate program;
 one member will serve as chair
 Graduate program director is usually involved in the committee selection
 A thesis master's committee (and not a non-thesis master's committee) can include
 one non-program member (with approval of the graduate program director)
 Must be registered for courses and/or research (Need ≥ 1 research credit/semester)
 ≤ 3 semesters are allowed for research only

Final Exam, Paper, or Project:

Must apply for candidacy to the master's program ≥ 2 mos. before the final exam. The
 master's candidacy form must be provided to the committee chair at the time of
 the final exam. After the exam, the student brings the form to the graduate
 program director to sign; then s/he returns the form to the Graduate School.
 May be written, oral, or both
 Can be the qualifying exam
 Master's thesis should be prepared in strict accordance with the instructions given in
 the Style Guide for Thesis and Dissertation Preparation
 Must be approved by the professor in charge and accepted by other members of the
 committee
 Student files a diploma application through the registrar's website
 The thesis must be filed electronically with the Graduate School of New Brunswick

II. Quantitative Biomedicine Program Requirements for Ph.D. and Master's Programs (These requirements are in addition to the Rutgers requirements)

A. Quantitative Biomedicine Doctor of Philosophy (Ph.D.) Requirements

Course Requirements:

The curriculum is designed to provide a solid base for working collaboratively to tackle
 diverse challenges in quantitative biology, enhanced by the personalized addition of student-
 specific courses or mini-courses to provide an education pertinent to the trajectory of the
 student's areas of interests and research.

**Any substitutions of required courses require prior approval by the Graduate Program
 Director or Associate Graduate Program Director. A grade of B or better is necessary.**

Year 1

Semester 1: 1 course from each Track (A, B, C) and the Seminar in Quantitative Biomedicine

TRACK A: Physics and Chemistry of Living Matter

Biophysical Chemistry I 16:160:537 (3 cr)
 Computational Chemistry 16:160:579:04 (3 cr)

TRACK B: Data, Computation, and Statistics

1. A Computer Science Master's level course or the equivalent (by arrangement with the Graduate Program Director or Associate Director in QB)

Introduction to Artificial Intelligence 16:198:520 (3 cr)
 Python Methodologies 16:137:552 (3 cr)

2. A Statistics course:

By arrangement with the Graduate Program Director in Statistics and Biostatistics
 or
 Bayesian Analysis 16:215:571 (3 cr)

3. A Bioinformatics course:

UNDERGRADUATE:

Evolutionary Genetics 01:447:486 (3 cr if do extra project)

GRADUATE:

Introduction to Biological Databases and Data Archiving 16:848:509 (3 cr)
 Clinical Research Informatics 16:137:580 3 cr
 Bioinformatics: Tools for Genomic Analysis/Tools for Bioinf. Analysis 16:137:617 (3 cr)
 Fundamentals of Analytics and Discovery Informatics 16:137:550 (3 cr)
 Bioinformatics 16:765:585:01 (3 cr)

TRACK C: Quantitative Modeling in Biology

Dynamical Models in Biology 16:848:504 (3 cr)
 Conversational Mathematical Modeling 11:216:458 (3 cr)
 Mathematical Modeling for Biomedical Engineering 16:125:501 (3 cr)
 An applied math modeling course (by arrangement with the Graduate Program Director or Associate Director in QB)

Seminar in Quantitative Biology: 16:848:616:01 (1 cr; to be taken 6 times during graduate school))

Semester 2: 2 courses from Track A or B or C, 1 course from a different Track, and Seminar in QB**TRACK A: Physics and Chemistry of Living Matter**

Physics of Living Matter 16:1848:617:01 (3 cr)
 Biophysical Chemistry II 16:160:538 (3 cr)

TRACK B: Data, Computation, and Statistics

1. A Computer Science Master's level course or the equivalent (by arrangement with the Graduate Program Director or Associate Director in QB)

Introduction to Artificial Intelligence 16:198:520 (3 cr)
 Python for Data Science 16:137:603 (3 cr)

2. A Statistics course:

By arrangement with the Graduate Program Director in Statistics and Biostatistics

3. A Bioinformatics course:

UNDERGRADUATE:

Quantitative Biology & Bioinformatics 01:447:302 (3 cr if do extra project)
 Genome Evolution 01:447:352 (3 cr if do extra project)

Conversational Mathematical Modeling 11:216:458 (3 cr if do extra project)

Fundamentals of Genomics 11:216:465 (3 cr if do extra project)

GRADUATE:

Microbiology and Human Health - being developed - (3 cr)

Computer Integrated Interventions in Medicine 16:125:623 (3 cr)

Bioinformatics: Tools for Genomic Analysis 16:137:617 (3 cr)

Fundamentals of Analytics and Discovery Informatics 16:137:550 (3 cr)

Introduction to Cloud and Big Data Systems 16:137:602 (3 cr)

Tools for Bioinformatic Analysis 16:137:617 (3 cr)

TRACK C: Quantitative Modeling in Biology

Dynamical Models in Biology 16:848:504 (3 cr) (Note: offered occasionally)

Mathematics of Cancer 01:640:459 (3 cr) (Note: not always offered; extra work required for graduate credit)

Discreet and Probabilistic Models in Biology 01:640:338 (3 cr) (Note: extra work required for graduate credit)

Mathematical Modeling for Biomedical Engineering 16:125:501 (3 cr)

An applied math modeling course (by arrangement with the Graduate Program Director or Associate Director in QB)

Seminar in Quantitative Biology: 16:848:616:01 (1 cr)

Interdisciplinary Quantitative Biology Boot Camp: ≥ 2 cr to be taken during graduate school

Winter Session of any Year(s) in Graduate School:

Interdisciplinary Quantitative Biology Boot Camp 16:848:615 (2 cr) or 16:848:601 (1 cr)

and/or:

Summer Session of any Year(s) in Graduate School:

Interdisciplinary Quantitative Biology Boot Camp 16:848:615 (2 X 1 cr)

Year 2

Seminar in Quantitative Biomedicine (2 X 1 cr): 16:848:616:01, Fall and Spring

Topics in Quantitative Biomedicine (2 X 1 cr): being developed, Fall and Spring

Molecular Medicine 16:848:XXX: being developed

Ethical Conduct in Scientific Research: available in most science- or engineering-oriented graduate programs.

Responsible and Ethical Research I: 16:486:501 (0 cr)

Introduction to Research: 16:160:603 (1 cr)

Ethical Scientific Conduct: 16:115:556 (1 cr)

Specialized electives course(s) (≥ 1 credit in a relevant area of study): This may consist of regular courses, mini-courses, or other approved entities.

A. Examples of mini-courses in Molecular Biosciences (16:695:622-635):

The Cilium, Organelle of the 21st Century

Cancer and Clinical Oncology

Cancer Genes and Cells

Evolution of Emerging Viruses

Noncoding Regulatory RNA

Toll-Like Receptors in Health and Disease

Molecular Biology of Cancer

P53
 Understanding of the Ubiquitin/Proteasome System and its Involvement in Disease
 Neural Circuit Microscopy
 Pluripotent and Somatic Stem Cells
 Regenerative Medicine - Stem Cell Therapy
 Neurodevelopmental Disorders
 Genetic Systems and Structures
 Genetics and Cell Biology of Fertilization

B. Examples of regular courses of possible interest:

Fundamentals of Molecular Biosciences 16:695:538 (6 cr)
 Experimental Methods in Molecular Biosciences 16:695:539 (2 cr)
 Molecular Biology of Cells 16:148:514 (3 cr)
 Molecular Biology and Biochemistry 16:115:511/512 and 16:694:407/408 (3 cr)
 Biochemistry 16:115: 503 or 504 (4 cr)
 Molecular Basis of Physiology 16:761:580 (3 cr)
 Genetic Systems and Structures 16:848:617:02 (3 cr)
 Human Genetics 16:681:535 (3 cr)
 Cancer 01:447:495 (3 cr)
 Cell & Molecular Pharmacology: Principles of Drug Action and Targeting 16:718:680 (3 cr)
 Drug Delivery: Fundamentals and Applications 16:125:590 (3 cr)
 Introduction to Applied Mathematics 01:640:321 (3 cr)
 Biocontrol, Modeling and Computation 16:125:572 (3 cr)
 Thermal Physics 01:750:351 (3 cr)
 Quantum Mechanics and Atomic Physics 01:750:361 (3 cr)
 Advanced Topics in Statistical Mechanics and Biological Physics 16:750:677 (3 cr)
 Physical Chemistry: Biochemical Systems 01:160:341 or 342 (3 cr)
 Concepts in Nanochemistry 16:160:579:01 (3 cr)
 Computational Chemistry 16:160:579:04 (3 cr)
 Chemical Thermodynamics 16:160:525 (3 cr)
 Thermodynamics and Kinetics 16:160:541:01 (3 cr)
 Structural Biology, Structural Biophysics and Chemical Biology of Transcription/Structural
 Biology/Biophysics 16:160:580 (3 cr)
 Communicating Science 16:718:560 (0 cr)
 Graduate Writing 16:355:502 (0 cr)

Year 3

Semester 1: Seminar in Quantitative Biology: 16:848:616:01 (1 cr)

Semester 2: Seminar in Quantitative Biology: 16:848:616:01 (1 cr)

Financial Support:

All incoming QB Ph.D. students are normally provided with financial support in their first year, including a competitive stipend and tuition remission. This support may come in the form of a teaching assistantship (TA), a graduate (research) assistantship (GA), or a graduate fellowship (GF). Students who progress productively toward their degree can anticipate full funding until the Ph.D. is awarded.

Teaching Assistantships:

Teaching assistantships (TAs; 6 credits/semester) are not formally required, but teaching of some form is required. A possible alternative to doing a TA could be assisting with several aspects of teaching for a course (by arrangement with the professor). This might consist of such activities as preparing and performing demonstrations, preparing and grading quizzes, and/or preparing and providing a lecture. This kind of alternative teaching can be arranged upon agreement with the Graduate Program Director or Associate Director and the professor teaching the course (and can be indicated on the student transcript as 'Teaching Apprenticeship').

Graduate Assistantships:

Graduate assistantships (GAs; 6 credits/semester) are not formally required, but serve as a common form of support after the student's first year. GAs are funded by grants, typically earned by the student's research advisor.

Graduate Fellowships:

Graduate fellowships (GFs; 6 credits/semester) are not formally required, but generally consist of a prestigious, merit-based form of support. GFs can be provided by the graduate program (e.g., from training grants) or by outside sources (e.g., from student-written proposals).

Seminar in Quantitative Biomedicine (6 X 1 cr): 16:848:616:01

Quantitative Biomedicine graduate students are required to take the 1-credit Seminar in Quantitative Biology course for 6 semesters of graduate school (including the first 2 semesters). Students must attend at least 10 seminars per semester (at least 7 of which are of a cross-disciplinary nature). Additionally, unless there are extenuating circumstances (to be discussed with the course instructor), the 10-seminar requirement must include at least 5 seminars of the IQB and CABM seminar series along with the post-seminar lunches with the speaker. This course is required a total of 6 times during graduate school (normally in the first 6 semesters). The student will provide a record of the seminars attended as well as a four-sentence description of each seminar.

The purpose of the seminar course is to learn about diverse topics in the broad field of quantitative biology and to obtain an awareness of new discoveries and technologies that could conceivably impact one's own research efforts, either currently or in the future. The post-seminar lunches serve to promote ease in speaking with fellow scientists in an intellectual and social atmosphere.

For this requirement, students are expected to attend seminars of an interdisciplinary

nature, including those of the [IQB & CABM series](#), the [Center for Quantitative Biology series](#), and the [Systems Biology/Bioinformatics meetings](#) at CINJ (by contacting Cheri Coleman at CINJ, colemacj@cinj.rutgers.edu). Students who wish to attend another seminar series will need to obtain consent from the Graduate Program Director or Associate Director. Students will provide a record of their seminar attendance in the form of 2 350-500-word abstracts and 8 4-sentence descriptions of 10 seminars attended.

Research Rotations:

In the first year, students engage in 3 rotations (16:848:621 & 622; 1 credit per 7-week rotation). Rotations provide the opportunity to explore research in the quest of finding a research group in which to do one's dissertation research. The format for lab rotations varies depending upon the research group. Students may be given an independent laboratory or theoretical research project and/or may assist other members of the lab in data acquisition and analysis. During this time, the student attends and participates in laboratory group meetings and related events. Students are responsible for arranging their own laboratory rotations by contacting faculty with whom they are interested in having rotations. Students should talk with faculty about their interest at the beginning of the first year (or, better yet, before arriving), as labs fill up quickly.

Choosing a Research Advisor:

Students choose a research advisor during their first year of graduate studies. In most cases the research advisor will be one of the faculty members with whom the student has completed a research rotation. Once a student has chosen a research advisor, the Thesis Advisor Form must be filled signed and returned to the office of the Associate Director of Graduate Studies (see Forms).

Students who have not joined a laboratory by the end of the first year should consult with the director of the graduate program. Failure to join a lab by the end of June may affect student support during the summer.

Some possible questions you may wish to ask faculty when are looking for your research adviser are:

1. Are you taking students?
2. How many graduate students do you have?
3. How many postdocs do you have?
4. How many students are on GA support?
5. How do you decide who gets a GA?
6. How long, on average, does it take to get a Ph.D. degree in your lab?
7. How many papers does an average student co-author?

8. Do your students present their work at national meetings?
9. What do you look for in a graduate student?
10. How do you like to run your group? Group meetings? Independence?
11. Can you give me some sense of the kinds of positions your students have taken in recent years?

Good Academic Standing:

A student is considered to be in good academic standing if s/he: (1) is a member of a research group where s/he is deemed to be progressing with appropriate conduct, (2) is taking/has taken appropriate courses and receives grades of A's and B's, and (3) is meeting the milestones defined by the QB graduate program.

Qualifying Exams:

A. Written Qualifying Exam (At the end of Year 1):

Students will have a written (or combination written/oral) qualifying exam at the end of their first year of graduate school during which they will demonstrate their working knowledge of the course material learned in three of the first year's courses (selected by the Graduate Program Director and Associate Director). This exam will consist of questions/answers and discussions pertaining to a broad range of topics addressed in the core courses and will be required of all Quantitative Biomedicine students.

Students will either pass the exam, be given a chance to retake the exam (or course) and retested, or will be terminated from the program, depending on their performance.

B. Admission to Candidacy Exam (By the end of Year 2):

Students will have a written and oral admission-of-candidacy exam with the Admission to Candidacy Exam committee, focused on the student's proposed thesis research.

1) Written component:

Students prepare a written proposal for their thesis research that must not exceed 20 pages single-spaced (not including references). The preparation of the proposal is intended to educate the student (about the work that has been done in the field to date and the techniques that will be useful for the work, the "how to" and the principles) and to promote creative thinking about the outstanding problems in the field and ways to solve these problems. The written proposal must be given to the student's committee members at least two weeks in advance of the oral exam. The student should obtain the [Application for PhD Candidacy](#) and provide it to the chairperson of the committee at the time of the examination (for signatures at the end of the exam, to be returned to

the Graduate School by the student).

2) Oral component:

Students will defend the proposal and show relevant knowledge in an oral presentation of approximately 45-60 minutes in duration. The presentation may be open to the public if the student and committee agree. The date for this component of the qualifying exam shall be set up with the committee members at least one month in advance. The proposal shall be distributed at least two weeks before the scheduled date of the exam. The Exam Committee will meet after the presentation and decide among the following three options: (1) Pass; (2) Fail; (3) Fail with an opportunity to repeat the exam. In the case of option #3, the student must repeat the exam within 3 months after the first exam. Repeat exams will be graded as Pass or Fail only. The student should obtain the [Application for PhD Candidacy](#) and provide it to the chairperson of the committee at the time of the examination (for signatures at the end of the exam). A copy of this form must be provided to the office of the Associate Director of Graduate Studies and the original signed copy must be brought to the Graduate School. If the student does not pass the qualifying exam, s/he may be eligible to earn a Master's degree at this stage. (See QB Master's Program section for details.)

Committee for the Admission to Candidacy Exam (subsequently the Thesis Advisory Committee):

By the Spring of the second year of graduate studies, the student and her/his thesis advisor (who is a full member of the QB graduate program faculty) discuss three additional faculty members who would be well suited to serve on the written and oral Admission to Candidacy Exam (as well as on subsequent annual thesis advisory committees). Given that QB is interdisciplinary in nature, an "outside" member may be from any relevant graduate program or institution provided s/he can provide a relevant perspective as a non-expert in the student's area of focus. Unless there is a compelling reason to do otherwise, the outside member should not be chosen from the same department as that of the student's advisor. The committee will be responsible for evaluating the student's candidacy for the doctoral degree at the qualifying examination defense (and later for offering feedback, insights, and guidance at subsequent meetings). The candidate should request member participation by contacting the preferred faculty members.

The committee will meet the student at least once a year (typically in May) to assess the student's research progress and provide guidance. The Admission to Candidacy exam is to be chaired by one of the faculty members other than the student's advisor. Subsequent Thesis Advisory Committees are to be chaired by the student's research

advisor (or co-chaired by co-advisors). At the end of each Thesis Advisory Committee meeting, the faculty members will all sign the QB Annual Research Advisory form on which the advisor will summarize the student's status/progress. This form must be returned to the office of the Associate Director of Graduate Studies.

Meetings with Graduate Program Director and/or Associate Director:

In the Fall of years one and two and in April or May of each year of graduate study, graduate students arrange to meet with the graduate program director and/or associate director (for an overview, evaluation of progress, and guidance). During each year, students must make sure they are meeting their milestones and maintaining a GPA of ≥ 3.0 .

Final Ph.D. Defense:

The student will submit his/her Ph.D. dissertation to his/her committee members and defend his/her thesis work in a public oral presentation of approximately 45 to 60 minutes in duration, demonstrating expertise in the meaning of his/her research and in relevant areas of knowledge. The thesis should be distributed and the date for this component of the qualifying exam should be set up with the committee members at least three weeks before the scheduled date of the exam. The Exam Committee will meet after the exam and decide among the following three options: (1) Pass and make suggested revisions to the thesis; (2) Perform additional research and then pass with suggested revisions to the thesis; (3) Fail with an opportunity to repeat the exam. In the case of option #3, the student must repeat the exam within 3 months after the first exam. As with the annual Thesis Advisory Committee meetings, the faculty members will all sign the QB Annual Research Advisory form on which the advisor will summarize the student's performance in the final defense and over the course of graduate study. This form must be returned to the office of the Associate Director of Graduate Studies.

B. Quantitative Biomedicine Master of Science (M.S.) Requirements:

The Master of Science in Quantitative Biomedicine will be available only to students enrolled in the existing Ph.D. in Quantitative Biomedicine program; students will not be admitted to Quantitative Biomedicine as a Master of Science student. Students are entitled to seek a 30-credit M.S. while enrolled in the doctoral program provided they demonstrate a Master's level of achievement **whether or not they are moving forward to Ph.D. candidacy**. This will allow such students to either be recognized for their interdisciplinary training at this stage or exit the doctoral program with a credential recognizing the knowledge and skills gained during their graduate study.

Coursework:

The course requirements are identical to those described for the Ph.D. program (above).

Financial Support:

Financial support is identical to that described for the Ph.D. program (above).

Research Rotations:

The research rotation requirements are identical to those described for the Ph.D. program (above).

Choosing a Research Advisor:

Choosing a research advisor is identical to that described for the Ph.D. program (above).

Qualifying Exam Committees:

If the student is on track toward her/his Ph.D., s/he will choose her/his committee(s) as described for Ph.D. students. If the student will not be continuing on the path to her/his Ph.D., the Qualifying Exam committee may consist of three faculty members, one of whom may be an outside member.

Qualifying Exam:

If the student wishes to obtain her/his Master's *en route* to obtaining a Ph.D., then the qualifying exam will follow the rules of the Admission to Candidacy Exam described for the Ph.D. program (above).

If the student knows beforehand that s/he will be leaving with a Master's degree, then the Rutgers requirements for a Master's degree will be followed as outlined in Rutgers Master's Degree Requirements (above).

Thesis and Non-Thesis Options:

Thesis and non-thesis options are identical for those established by Rutgers University (described above).

Final Exam, Paper or Project:

The final exam, paper, or project will follow the requirements established by Rutgers University (described above).

C. Quantitative Biomedicine Master of Philosophy (M.Phil.) Requirements:

The Master of Philosophy in Quantitative Biomedicine is another type of Master's degree offered at Rutgers, intended to serve as a super-Masters for those interested in this option. The M.Phil. will be available only to students enrolled in the existing

Quantitative Biomedicine Ph.D. program; Quantitative Biomedicine as a Master of Philosophy student. Students are entitled to seek a 30-credit M.Phil. while enrolled in the doctoral program provided they demonstrate a Master's level of achievement **whether or not they are moving forward to Ph.D. candidacy**. It is expected that any student earning an M.Phil. will have demonstrated excellence in his/her research. This will allow such students to either be recognized for their interdisciplinary training at this stage or exit the doctoral program with a credential recognizing the knowledge and skills gained during his/her graduate study.

Coursework:

The course requirements are identical to those described for the Ph.D. program (above).

Financial Support:

Financial support is identical to that described for the Ph.D. program (above).

Research Rotations:

The research rotation requirements are identical to those described for the Ph.D. program (above).

Choosing a Research Advisor: Choosing a research advisor is identical to that described for the Ph.D. program (above).

Qualifying Exam Committees:

If the student is on track toward her/his Ph.D., s/he will choose her/his committee(s) as described for Ph.D. students. If the student will not be continuing on the path to her/his Ph.D., the Qualifying Exam committee may consist of three faculty members, one of whom may be an outside member.

Qualifying Exam:

If the student wishes to obtain her/his M.Phil. *en route* to obtaining a Ph.D., then the qualifying exam will follow the rules of the Admission to Candidacy Exam described for the Ph.D. program (above).

If the student knows beforehand that s/he will be leaving with a M.Phil. degree, then the Rutgers requirements for a Master's degree will be followed as outlined in Rutgers Master's Degree Requirements (above).

Thesis and Non-Thesis Options:

Thesis and non-thesis options are identical for those established by Rutgers University (described above).

Final Exam, Paper or Project:

The final exam, paper, or project will follow the requirements established by Rutgers University (described above).

- III. Joint Ph.D. Degree Program Encompassing Quantitative Biomedicine and Partnering Graduate Programs:** The Joint Ph.D. degree program provides graduate students with the opportunity to seamlessly extend their academic and research training beyond a core discipline to include interdisciplinary experience.

How the Quantitative Biomedicine Joint Degree Program Works:

- Students enroll in one of the partnering graduate programs (PGP).
- Students enroll in the QB program, either concurrently or later in their graduate education.
- Once accepted into the joint degree program, a QB *joint degree track* is selected to coincide with that of the PGP conferring the disciplinary degree. (This track follows the degree requirements for the PGP and sets the *format* for the qualifying examinations and the final thesis defense.)
- While all diplomas for graduate degrees from Rutgers are designated as “Doctor of Philosophy” without further specification of the discipline, the formal degree that is awarded is the joint degree, designated as “Ph.D. in <PGP> and Quantitative Biomedicine.” This is also indicated on the student’s transcript.
- Students enrolled in the Joint Ph.D. program with QB have the option to earn a Master’s of Science degree in QB

Research Advising:

- A student receiving a Joint Ph.D. degree with QB and a PGP has either: (1) one advisor who is a member of the Quantitative Biomedicine graduate faculty and also a member of the PGP graduate program faculty or (2) a primary advisor who is a member of the PGP graduate faculty and a co-advisor who is on the QB graduate faculty. If the student opts out of working with a QB-associated graduate faculty member during her/his first academic year, s/he will become solely a PGP student (and will not be eligible for a Joint Ph.D. or any Joint Ph.D. awards).
- In addition to the requirement for an advisor or co-advisor from the QB faculty, there is a requirement for at least one additional (i.e., a second) QB faculty member on each Joint Ph.D. student’s thesis committee.

Academic Requirements:**Coursework:**

Students must satisfy ALL of the course requirements for the PGP degree.

Students must:

- Meet with the Graduate Program Director or Associate Director to determine the course needs for Joint Ph.D. students. Depending on the student's background and research area(s) of focus, Joint students will typically take an additional 1-3 courses. The course requirements will be chosen to ensure that Joint Ph.D. students get a broad, interdisciplinary education as well as fills in "gap" areas needed to enable the educational and research objectives of the student [in agreement with her/his advisor(s)] with minimal added course load burden.
- All Joint students are required to take at least one 2-week Winter Interdisciplinary Quantitative Biology Boot Camp, either as a student or an instructor.
- All Joint students are required to attend at least one interdisciplinary seminar/week during the first or second academic year. Joint students are encouraged to attend the IQB & CABM seminars and lunches toward meeting this educational requirement.

Financial Support:

Financial support is according to the primary graduate program.

Research Rotations:

Research rotation requirements are according to the primary graduate program.

Choosing a Research Advisor:

Choosing a research advisor is identical to that described for the Joint Ph.D. program (above).

Qualifying Exam Committees:

If the Joint student is on track toward her/his Ph.D., s/he will choose her/his committee(s) as described for Joint Ph.D. students. If the student will not be continuing on the path to her/his Ph.D., the Qualifying Exam committee may also serve as the Master's Defense Committee and may consist of three faculty members, none of whom must be a member of the Quantitative Biomedicine graduate program faculty and one of whom may be an outside member.

Qualifying Exam:

The format for and assessment of the qualifying examinations in the Joint Ph.D. program is defined by the PGP.

Final Ph.D. Defense:

- The Joint student will submit his/her Ph.D. dissertation to his/her committee members for review as per the standard for the primary graduate program (PGP), noting that the committee itself must include two members of the Quantitative Biomedicine graduate

- program faculty.
- Following the student's defense, the committee members will all sign the Ph.D. Candidacy form after which the Graduate Program Director or Associate Director will also sign.
 - The title page of the final, corrected thesis should indicate that the thesis is in partial fulfillment of the requirements for the degree of Doctor of Philosophy Graduate Program in <PGP> and Quantitative Biomedicine.

Quantitative Biomedicine Master of Science (M.S.) Requirements for Joint Ph.D. Students:

- Joint students may get a Master of Science (M.S.) degree in either their PGP or in Quantitative Biomedicine but not both (i.e., there is no Joint M.S.).
- Students are entitled to seek either a thesis M.S. or a non-thesis, 30-credit M.S. while enrolled in the doctoral program provided they demonstrate a Master's level of achievement **whether or not they are moving forward to Ph.D. candidacy**. This will allow such students to either be recognized for their interdisciplinary training at this stage or exit the doctoral program with a credential recognizing the knowledge and skills gained during their graduate study.

Academic Requirements:

Coursework:

The course requirements are identical to those described for the Joint Ph.D. program (above).

Financial Support:

Financial support is according to the primary graduate program.

Research Rotations:

The research rotation requirements are according to the primary graduate program.

Choosing a Research Advisor:

Choosing a research advisor is identical to that described for the Joint Ph.D. program (above).

Qualifying Exam Committees:

If the Joint student is on track toward her/his Ph.D., s/he will choose her/his committee(s) as described for Joint Ph.D. students. If the student will not be continuing on the path to her/his Ph.D., the Qualifying Exam committee may also serve as the Master's Defense Committee and may consist of three faculty members, none of whom must be a member of the Quantitative Biomedicine

graduate program faculty and one of whom may be an outside member.

Qualifying Exam/Master's Defense:

If the student wishes to obtain her/his Master's *en route* to obtaining a Joint Ph.D., then the qualifying exam will follow the rules of the primary graduate program.

If the student knows beforehand that s/he will be leaving with a Master's degree, then the Rutgers requirements for a Master's degree will be followed as outlined in Rutgers Master's Degree Requirements (above).

Admissions:

Direct entry method:

- Students apply to enter the Joint Ph.D. program via the PGP (following instructions provided on both the PGP and QB websites, indicating interest in the Joint Ph.D. program in the personal essay). Follow the instructions provided on the Graduate Admissions website and apply to the traditional program, which will be your primary program in conjunction with the Quantitative Biomedicine program. The program requirements will correspond to those of the primary program, with the added requirements of including some interdisciplinary coursework (which will often meet the requirements of the primary program) and an interdisciplinary component to the thesis research undertaken.
 - The Graduate School, New Brunswick GSNB: <http://gsnb.rutgers.edu>
 - Applying For Admission to Graduate School at Rutgers: <http://gradstudy.rutgers.edu/>
- The PGP directs graduate applications of interested students to the QB admissions committee for evaluation, requesting consideration for a joint degree.
- The PGP and QB admissions committees individually render their acceptance decisions.
- Acceptance by both programs results in admittance to the Joint Ph.D. program.
- Acceptance by the PGP only results in a traditional one-discipline education.

Delayed entry method:

- Students apply to the Joint Ph.D. program after beginning graduate school, providing a one-page personal statement, a recommendation letter(s) from the student's primary advisor and QB co-advisor (if the primary advisor is not a QB faculty member), the student's original graduate school application material, and (unofficial) transcript(s) corresponding to any previous programs of study. It is advisable to apply early during graduate school in order to receive the guidance and educational enhancement that come with being a Joint Ph.D. student.

- The QB admission committee evaluates the application and communicates a decision, typically within a month of its receipt.

IV. M.D./Ph.D. or M.D./Joint Ph.D. Program (Format)

Interested students can work toward an M.D./Ph.D. or an M.D./Joint Ph.D. with QB as the Ph.D. program or the secondary Ph.D. program, respectively. This education consists of:

First 2 years: Take the medical school curriculum; complete 2-3 research rotations; take USMLE Step 1 exams

Next 3-4 years: Conduct thesis research and participate in longitudinal clinical activities

Final 2 years: Complete core clinical clerkships; take USMLE Step 2 exams; apply for residency

The medical education program (including application instructions) is described [here](#).

Selection of the QB program for the Ph.D. or part of the Joint Ph.D. is normally done in conjunction with the student selecting her/his research group.

V. Quantitative Biomedicine Student Learning Goals

The doctoral program in Quantitative Biomedicine trains students at the highest level to assume leadership roles in interdisciplinary teams addressing problems at the interface of biology and medicine with the quantitative sciences.

Learning Goal 1 for Students: Attain marked ability, scholarship, research, and leadership skills at the interface of biology and medicine with the mathematical and physical sciences.

Assessment of student achievement of Goal 1:

- Grades in graduate courses
- Attendance of seminars and lunches with the speakers in the interdisciplinary Institute for Quantitative Biomedicine and Center for Advanced Biotechnology and Medicine seminar series
- Attendance of at least one Winter Interdisciplinary Quantitative Biology Boot Camp provided by the Institute for Quantitative Biomedicine as a student and/or instructor, with evolving areas of focus consisting of lectures, hands-on workshops, collaborative exercises, a student-organized final presentation, and daily career-training sessions
- Qualifying examinations assessing depth and breadth of knowledge
- Review of student progress by faculty and graduate program director/associate director with close advising and mentoring
- Publications in peer-reviewed journals (with at least one first-authorship publication expected)

- Guidance toward opportunities for and expected placement in positions and careers that benefit from ability and scholarship in those aspects of the biological sciences that can be enhanced through the application of techniques and concepts from the mathematical and physical sciences

Role of the program in helping students to achieve Goal 1:

- Close advising to assure that students are being prepared in a coherent and academically rigorous fashion
- Annual review of academic performance and progress toward a degree in the program by a three-member faculty committee
- Evaluations of effectiveness of assistant teaching
 - Student evaluation of overall effectiveness in teaching
 - If effectiveness is below expectations, the student is to work with instructors to improve her/his effectiveness
- Periodic review of curricular offerings, degree requirements and assessment tools
 - By program faculty, graduate program director, and associate program director
 - By consultation with the office of the dean of the graduate school

Learning Goal 2 for Students: Engage in and conduct original research

Assessment of graduate student achievement of Goal 2:

- Preparation of and defense of Ph.D. dissertation proposal
- Assessment of quality of Ph.D. dissertation:
 - Critical reading of dissertation by student's thesis advisory committee
 - Public defense of dissertation
- Submission and acceptance of peer-reviewed articles and conference papers and posters
- Achievement of professional placements
- Individual attainment of grants, fellowships, or scholarships, if applicable

Role of the graduate program in helping students achieve Goal 2:

- Provide comprehensive advising and assist in the identification of mentors
- Provide early introduction to opportunities for research and exposure to research topics and methods
- Announce opportunities for grants and fellowships
- Provide opportunities to present research and receive feedback
- Help to provide or identify alternative funding mechanisms

Learning Goal 3 for Students: Prepare to be professional in careers that require training at the highest levels of the interdisciplinary field of the quantitative and biological and medical sciences

Assessment of graduate student achievement of Goal 3:

- Review record of talks presented, publications, and professional networking
- Review evaluations of teaching effectiveness as a graduate student instructor
- Review record of graduate career placement

Role of the program in helping students achieve Goal 3:

- Develop, enhance, and announce programs related to job and networking skills, including activity in professional societies and preparation for necessary certifications
- Acquaint students with spectrum of career opportunities

The leadership of the Quantitative Biomedicine graduate program will regularly review the structure and content of the graduate program and the feedback received from assessments and surveys. These reviews will be used to provide the best possible education to students in order to meet the needs for highly trained individuals at the interface of biology and medicine with the quantitative sciences.

VI. Milestones for Graduate Study in Quantitative Biomedicine

A. Student Timeline

Year 1

- Orientation
 - Attend QB Orientation Session
 - Meet with Orientation Committee
 - Enroll in Fall semester courses
 - Talk with faculty whose research is of interest
- Fall
 - Take 3 3-credit courses plus 1-credit seminar course (10 course credits)
 - Meet with potential faculty advisors and do 1-2 rotations; it is recommended to arrange 3 rotations for the year at the **beginning** of the first year; submit QB Lab Rotation form at completion of each rotation
 - Possibly serve as a TA
 - Toward the end of the semester, meet with Associate Director to review Fall semester, consider Boot Camp for the Winter Session, and discuss courses and rotation(s) to take in the Spring semester
- Between semesters
 - Enroll in Spring semester courses
 - Possibly participate in Boot Camp
 - Arrange last rotation(s) if not yet arranged

- Spring
 - Take 3 3-credit courses plus 1-credit seminar course (10 course credits). Do 1-2 rotations
 - Possibly serve as a TA
- End of semester
 - Join a research group, with the PI agreeing to assume responsibility to supervise research and be responsible for financial support [through external grants, contracts, or University sources of support (*e.g.*, TAs)]. Provide Graduate Program Director or Associate Director with a signed Admission to a Research Group form.
 - Take written Qualifying Exam Part I demonstrating knowledge and understanding of material covered in 3 first year courses (to be selected by Graduate Program Director and Associate Director).
 - Meet with Director and/or Associate Director (evaluation of 1st year). Must maintain a GPA of ≥ 3.0 .
 - Enroll in Fall semester courses
- Summer
 - Start research
 - Work with faculty advisor to consider directions for thesis research and proposal

Year 2

- Fall
 - Take Seminar in Quantitative Biomedicine, Ethical Conduct in Scientific Research, and most likely a specialized course.
 - The student and his/her advisor agree on the four faculty members who will comprise the Admission to Candidacy exam committee. The chair of the qualifying exam committee is not the student's research advisor for the Admission to Candidacy exam; however, the student's research advisor will be the chair for subsequent meetings (detailed further in the Faculty Committees section).
 - The student submits the QB Qualifying Committee Selection Form to the Associate Director of Graduate Studies.
- End of semester
 - Meet with Graduate Program Director and/or Associate Director
 - Enroll in Spring semester courses and/or research
- Spring
 - Take Seminar in Quantitative Biomedicine and possibly a specialized course.
 - The student begins or continues with the production of her/his research proposal for the Admission to Candidacy exam.
 - In conjunction with the research advisor, the student suggests to her/his committee possible dates for the oral part of the Admission to Candidacy exam

- (Qualifying Exam, Part II).
- o At least 2 weeks in advance of the selected exam date, the student submits electronic copies of the research proposal to the committee members.
 - o The student takes the oral component of Admission to Candidacy exam (bringing with her/him the Ph.D. Candidacy form). The members of the exam committee evaluate the exam with a grade of Pass, Fail, or Revise. The Chair informs the candidate about the overall evaluation of the proposal and defense in the presence of the committee. If the student passes, s/he will go on to perform his/her thesis research.
 - o The student provides a copy of the signed Ph.D. Candidacy form to the QB Graduate Program Director or Associate Director and brings the original copy to the Graduate School. The student discusses her/his status with the Graduate Program Director or Associate Director at that time.
 - o If the student fails the exam, s/he will have the option to earn a Master's degree.

Year 3

- Spring
 - o Take Seminar in Quantitative Biomedicine (now or later, for a total of 6 enrollments).
 - o Meet with Thesis Advisory Committee (TAC) and report progress with written and oral presentations. The TAC is likely to be the same as the preliminary exam committee unless the student discusses making a change with his/her advisor(s) and the Graduate Program Director or Associate Director.
 - o Meet with Director and Associate Director (evaluation of 3rd year).

Year 4

- Spring
 - o Take Seminar in Quantitative Biomedicine (now or later, a total of 6 times).
 - o Meet with TAC and report progress with written and oral presentations.
 - o Meet with Director and Associate Director (evaluation of 4th year).
 - o Seek mentorship in professional/career preparation; communicate with potential future advisors/bosses

Year 5

- Seek mentorship in professional/career preparation; communicate with potential future advisors/bosses
- Prior to final defense, pick up Ph.D. Candidacy form from the Graduate School. Committee members will sign this at the conclusion of the defense.
- Have final defense: a public presentation followed by a meeting with the TAC
- Graduate Program Director or Associate Director signs form and student brings it to

the Graduate School.

- Graduate!

B. Faculty Advisor Annual Timeline

- Before Fall classes start
 - QB Orientation Session for students and some faculty
 - Possibly serve on some Orientation Committees
 - Discuss Fall semester courses with your students
 - Consider hosting rotation students
 - Talk with potential rotation students if applicable
- Fall
 - Discuss with your 2nd year students the selection of members for their Admission to Candidacy exam committee or the Thesis Advisory Committee
- Winter Session
 - Fall grades become available
 - Discuss Spring semester courses with your students
- Spring
 - Consider hosting rotation students
 - Talk with potential rotation students if applicable
 - 1st year students take their Written Qualifying Exam (Part I)
 - 2nd year students take their Admission to Candidacy Exam (Qualifying Exam (Part II))
 - 3rd year and more advanced students meet with their Thesis Advisory Committee (annually) and report progress with written and oral presentations; students also meet with Graduate Program Director and/or Associate Director
- Summer
 - Engage your 1st year students on research projects
- Toward end of student's graduate education
 - Provide mentorship to students regarding professional/career development (including possibly connecting them with some of your colleagues)
 - Guide students regarding their final defense

Appendix

Forms (available here and on our [website](#))

QB Forms

- [QB Admission to a Research Group](#)
- [QB Annual Research Advisory Form](#)
- [QB Learning Goals](#)
- [QB Lab Rotation Form](#)
- [QB Qualifying Committee Selection Form](#)

Joint Program Description

- [QB Joint Degree](#)
- [QB Joint Degree Acceptance Form](#)

Rutgers Forms

- [Application for Readmission](#)
- [Application for Transfer of Credits](#)
- [Checklist for Master's with Thesis](#)
- [Checklist for Master's without Thesis](#)
- [Checklist for Ph.D.](#)
- [GSNB Handbook](#)
- [Health Insurance Form for Graduate Students Registered as Part-time and Considered Full-time](#)
- [Master's Candidacy Form](#)
- [Master's of Philosophy Degree Application](#)
- [Master's of Science Degree Application](#)
- [Ph.D. Candidacy Form \(for Admission to Candidacy Exam and Ph.D. Defense\)](#)
- [Reduced Credit Course Load Form](#)
- [Restoration of Active Status Form](#)
- [RT100 Form \(Tuition Remission Form\)](#)
- [Style Guide for Thesis](#)
- [Thesis Payment Form](#)
- [University Exchange Registration Form](#)