Interdisciplinary Ph.D. in Quantitative Biosciences
Graduate Handbook
September 2019

Note: Most students will read this handbook in order to figure out how to **do** something en route to obtaining a Ph.D. in Quantitative Biosciences at Georgia Tech. Broadly, this handbook includes information on degree requirements – from courses to thesis – and administration of the program. The topics in this handbook will be summarized in the orientation for all incoming students. In addition, all students are encouraged to review this document on a yearly basis.

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A. Introduction

This document describes Georgia Tech's Interdisciplinary Graduate Program in Quantitative Biosciences. The program was founded in 2015. This document includes detailed information about the program of study, degree requirements, financial support, administrative matters, facilities, etc. Specific questions should be addressed as needed to the Director of the Program – director@qbios.gatech.edu - and to the administrative support – admin@qbios.gatech.edu. *Updates to this handbook will be announced to students & faculty and posted on the QBioS website – http://qbios.gatech.edu.*

Director of Program

Joshua S. Weitz, Ph.D., Professor
School of Biological Sciences, Georgia Institute of Technology
director@qbios.gatech.edu

Graduate Committee

Joshua Weitz (Chair, SoBS), Bridgette Barry (CHEM), Annalisa Bracco (EAS), Sam Brown (SoBS), Leonid Bunimovich (MATH), Flavio Fenton (PHYS), Simon Sponberg (PHYS), Matthew Torres (SoBS), Peter Yunker (PHYS)

Administrative Manager

Lisa Redding, School of Biological Sciences, admin@qbios.gatech.edu

Home Schools

Biological Sciences – SoBS
Chemistry and Biochemistry – CHEM
Earth and Atmospheric Sciences – EAS
Mathematics – MATH
Physics – PHYS
Psychology – PSYC

B. Deadlines and Timelines

The timelines represent a typical trajectory and issues of exceptions are dealt with in the appropriate sections of the handbook.

B.1 Major Milestones

Time/Years	Milestone	Instructions
0-1.5	Core course completion	See Program of Study
1.0	Selection of thesis advisor	See Program of Study
1.0	Formation of initial Ph.D. committee	See Program of Study
2.0	Written proposal and oral defense	See Ph.D. Thesis
3.5 – 4.5	Thesis approval	Must occur 6 months prior to defense
5	Thesis Defense (with at least one publication)	Approval form signed by committee and must be submitted to the QBioS Office
Continuous	Yearly Updates	Scheduled by the Student

B.2 Typical Timeline for Completion of a Ph.D. in QBioS

The QBioS program is designed to keep students on track for learning core material and proposing a thesis dissertation in years 1 and 2. Subsequently, the student, advisor and committee collaboratively ensure the development and completion of the thesis in years 3-5. The five-year schedule of a typical student will involve classes, research and teaching experiences, as below. Detailed information on each component is provided in subsequent sections.

Year 1

	Fall semester	**Spring semester**	**Summer semester**
Recommended 1st year program **Including:** **A – Courses** **B – Rotation + research** **C – Teaching**	A1. Foundations in QBioS (4 hours) A2. Quantitative Modeling (3 hours) A3. Elective in Biosciences (3 hours) A4. QBioS Seminar (1 hour) C. Teaching assistantship (3 hours, home school)	A1. Quantitative Modeling (3 hours) A2. Elective in Biosciences (3 hours) A3. QBioS Seminar (1 hour) A4. RCR training B. Rotation (6 hours) C. Teaching assistantship (3 hours, home school)	A. Required writing course (2 hours) B. Thesis research (12 hours) (support expected from GRAs)

Year 2

	Fall semester	**Spring semester**	**Summer semester**
Typical 2nd year program **Including:** **A – Courses** **B – Rotation + research** **C – Teaching**	A1. Quantitative Modeling (3 A2. Elective in Biosciences (3 hours) B1. Thesis research (9 hours) (support expected from GRAs)	A1. Interface minor (3 hours) B1. Thesis research (12 hours) B2. Thesis proposal development (support expected from GRAs)	B1. Qualifying exam and thesis proposal evaluation B2. Thesis research (12 hours) (support expected from GRAs)

Years 3-4 – Students should have passed their qualifying exams and will devote near 100% of their time to thesis related research. They are encouraged to take additional classes in consultation with their thesis advisor and committee.

Year 5

	Fall semester	**Spring semester**	**Summer semester**
Typical final year program **Including:** **A – Courses** **B – Rotation + research** **C – Teaching**	B1. Thesis research (12 hours) B2. Pre-defense committee meeting with preview of thesis (support expected from GRAs)	B1. Thesis research (12 hours) B2. Publication submitted for review and/or revision. (support expected from GRAs)	B1. Thesis research (12 hours) B2. Thesis defense and public examination (support expected from GRAs)

C. Degree Requirements

C.1 Summary of Requirements

The Ph.D. in Quantitative Biosciences is designed to give graduates training in the quantitative analysis of problems in the biosciences – spanning foundational advances and application to challenges in human health, energy and the environment. The requirements include:

(1) a program of study in core QBioS biosciences and quantitative modeling courses;
(2) a coherent interface Minor course of study;
(3) a minimum of two group rotations in the first year;
(4) an English writing class;
(5) a Thesis Proposal;
(6) acceptance of at least one scientific publication;
(7) a written Ph.D. thesis and a public defense of that thesis.

There is no comprehensive qualifying exam and no foreign language requirement. Georgia Tech requires that all doctoral students maintain a 3.0 grade point average. With the permission of the research supervisor and the QBioS Director, Ph.D. students may seek a concurrent MS degree from another School. If so, the courses taken for the MS may be counted to satisfy the Minor requirement. During the semester preceding the semester when the Ph.D. degree is expected, students must submit an Online Application for Graduation to the Registrar. The complete set of requirements involving credit hours are listed in the following Table. The majority of coursework should be completed in years 1-2, with thesis research representing the bulk of credit hours in years 3-5:

Requirement	**Hours**
Foundations in Quantitative Biosciences (1 course)	4
Seminars in Quantitative Biosciences (2 courses)	2
Quantitative Modeling core, including a computational-focused class (3 courses)	9
Bioscience disciplinary electives (2 courses, including one involving the application of quantitative methods to the biosciences)	6
Quantitative Models in the Biosciences (1 course)	3
Scientific interface minor (3 courses, equivalent to Institute approved minor, of which 3 hours must be distinct from courses listed above)	9 (3 new)
Rotations	6
Thesis research	15 (minimum)
Total	**25 core course hours** **2 seminar hours** **6 rotation hours** **15 thesis hours**

C.2 Program of Study

First-year students are required to take a foundations course, two seminar courses, two modeling courses and two bioscience courses in their first year. Students are expected to earn course grades of A, B, or P (pass) in both semesters. One course grade of C is permitted in either the first or second semester (not both). Students who earn two or more grades of C or any number of D or F grades may not continue in the Ph.D. program without the explicit permission of the

QBioS Graduate Committee. Incoming Ph.D. students demonstrate their grasp of the core principles of Quantitative Bioscience by taking multiple courses (described below). Note that the Seminars in Quantitative Biosciences are taken on a pass/fail (P/F) basis. The other core courses **must** be taken on a letter grade (LG) basis. Course listings are found in Appendix B but may, in some instances, also be selected across the Institute's offerings via permission of the student's supervising committee.

C.2.1 Core courses

Core Introductory Courses – All Required

I1.	BIOL 8804 or 8814	Foundations of Quantitative Biosciences (4 hours)
I2.	BIOL 8801	Seminar in Biology – Quantitative Biosciences (1 hour)
I3.	BIOL 8801	Seminar in Biology – Quantitative Biosciences (1 hour)

These three courses taken in the first year are taken by all QBioS Ph.D. students. The Foundations class is organized around the understanding of key advances in the biosciences, one organizing unit at a time, in which the advances depended critically on quantitative methods and reasoning. The overall objective of the course is to teach graduate students how to reason quantitatively in the biosciences given uncertainty in mechanisms, rates and reliability of measurements. The Seminar classes will enable students to meet, learn and discuss rotating topics representing ongoing advances in QBioS with Program Faculty.

Quantitative Modeling Core (3 courses):
Students select courses *a la carte* that involve rigorous quantitative methods and models.

Bioscience Disciplinary Electives (2 courses):
Students select courses *a la carte* that deepen student understanding of the biosciences in one of the following areas:

- Chemistry of Biological Systems
- Molecular and Cellular Systems
- Physiology & Behavior
- Ecology
- Evolution
- Earth Systems

Quantitative Models in the Biosciences (1 course):
Students select one course *a la carte* that satisfies the requirement that students take a course involving the direct application of quantitative methods to the biosciences. All courses satisfying this requirement are 3 credit hours, including problem sets, involving mathematical and computational methods.

C.2.2 Interface minor

Students select three courses that will enhance the thesis and enable the development of breadth and flexible thinking in the student. This requirement will also serve, in part, to satisfy the Institute required minor. One of these courses must be in addition to those taken as part of the core course requirements.

C.2.3 Rotations

Special Problems (BIOL 8901) is two, 3-hour courses arranged with two distinct QBioS program faculty members in the spring semester of the first year. Registration requires the permission of two professors. The Special Problems should be viewed as a serious opportunity to begin Ph.D. research. Students should also register for a Special Problem in the summer of their first year for 12 credit hours. In most cases this course will have a single professor using the special problem designation appropriate to the School of the advisor and the special problem advisor will represent the eventual thesis advisor of the student. However, students are permitted to arrange for up to 2 additional rotations using Special Problems mechanism in the summer of their first year. Selection of a thesis advisor is expected for all students by the end of their first year in the program.

C.2.4 Academic Writing Requirement

All students must demonstrate competency in academic and technical writing to complete the academic writing requirement. The student's TPC is responsible for evaluating this requirement, thorough evaluation of first-authored publications and/or the thesis proposal. In the event that students require additional training, the TPC may recommend that students take and pass a semester-long graduate course in English-language academic writing. For non-native English speakers, the relevant course is CETL 8723. Non-native speakers may also take ESL-OL01L thorough the GT Language Institute. This online course is aimed at international graduate students and helps them develop a fundamental understanding of the basic principles of academic research writing. For native English speakers (or non-native speakers with extremely good English grammar skills) the relevant course is CETL 8721. At this time, the Center for Teaching and Learning plans to offer the 8721 course during summer semesters only. For all students, the writing requirement should be discussed as part of the initial TPC meeting and the initial evaluation of the writing requirement should be completed no later than the end of the 2nd year, consistent with the scheduling of the thesis proposal.

C.2.5 Approval of Thesis & Advancement to Candidacy

By the **end of the second summer** at Georgia Tech, every QBioS Ph.D. student must seek admission to candidacy by presenting a 10-page Proposal, including 2 additional pages of references to a Thesis Proposal Committee (TPC) composed of their primary research supervisor and 3 other faculty members; of these 3, at least one must be from the QBioS program faculty. Every student is required to defend their Proposal to their TPC in the form of a 45 minute oral presentation followed by brief questions from the public, followed by an additional 30-60 minutes of questions from the committee. The written Thesis Proposal should contain (1) a review of the literature of their field; (2) a discussion of how the proposed research fits into that field; and (3) a summary of preliminary results. Each TPC member (except for the supervisor) is expected to ask questions designed to probe the students' understanding of their proposed research. It is the responsibility of the TPC to decide if the student "passes'' or "fails'' the Thesis Proposal. A student who passes is formally admitted to Ph.D. candidacy. A student who fails must rewrite his/her Thesis Proposal and/or repeat the oral presentation no later than the subsequent semester as directed by their TPC.

C.2.6 Publication Requirement

Some portion of the Ph.D. candidate's research must have been accepted as a "first-author" publication in a refereed scientific journal before the thesis defense. Given differences in fields and author order conventions, here we use the term "first-author" to denote the person primarily (or equally) responsible for conducting the research that led to publication. The term first-author applies to "joint" designations of first-authorships. In fields in which last name ordering is used, the "first-author" requirement is satisfied so long as the student was primarily – whether solely or jointly – responsible for conducting the research that led to publication. Note that if your work was supported in part by the QBioS program thorough a program GRA, then you should include an Acknowledgement as such: "This work was supported in part by the Interdisciplinary Graduate Program in Quantitative Biosciences at the Georgia Institute of Technology."

All publications arising during your PhD include 2 addresses:

1. Interdisciplinary Graduate Program in Quantitative Biosciences;
2. Your home school (School of Biological Sciences, School of Physics, etc.).

The physical address can be the same (i.e., Georgia Institute of Technology, Atlanta, GA 30332).

C.2.7 Thesis Defense

The thesis defense is the capstone of the QBioS Ph.D. – and is described in **Section D.**

C.3 Graduate Coursework from Other Universities and Programs

Graduate level course work taken for a Master's degree (even at another university) may be included in the Ph.D. Program of Study provided that a grade of B or better was earned for these courses. The submitted program of study and course justification should also include a copy of the student's transcript and a detailed course description and syllabus for each course for which the student wishes to receive credit.

C.4 Honor Code

All participants in QBioS Graduate Program are expected to uphold the Academic Honor Code at all times. The Honor Code is intended to continuously remind students and faculty of the importance of honesty and responsible conduct in their professional lives. It also serves to increase awareness on the part of both students and faculty of the rules regarding academic honesty and the process to be followed if these rules are broken. Since graduate students are involved in research and scholarly activities which occur outside the classroom, the Georgia Tech Academic Honor Code contains a Graduate Addendum to address additional aspects of academic integrity associated with such activities. Graduate students are also encouraged to become familiar with the Institute Policy on Scholarly Misconduct, located at http://www.policylibrary.gatech.edu/faculty-handbook/5.7-policy-responding-allegations-scientific-or-other-scholarly-misconduct.

D. Ph.D. Thesis

D.1 Selecting an Advisor

Students will rotate with two different QBioS faculty members in the spring of their first year, with additional opportunities for up to two more rotations in the summer of their first year. QBioS students should identify a thesis advisor no later than the end of the summer of their first year. Upon mutual agreement, the student and advisor will inform the QBioS graduate committee which will then review and confirm all requests.

D.2 Committee Formation

Students should identify a Thesis Proposal Committee (TPC) composed of their primary research supervisor and 3 other faculty members, of these 3, at least one must be from the QBioS program faculty. The TPC is responsible for evaluating the proposal and should be constituted in the fall semester of the 2nd year in the program – and hold an initial, advisory meeting with the student. In most cases the TPC members continue to serve as members of the Thesis Reading Committee after the student passes their qualifying exam.

D.3 Qualifying Exam

D.3.1 Written Thesis Proposal

By the **end of the second summer** at Georgia Tech, every QBioS Ph.D. student must seek admission to candidacy by presenting a 10-page Proposal, including 2 additional pages of references to a Thesis Proposal Committee (TPC). Criterion for evaluating the quality of the proposal will be distributed by the TPC to the student in advance of the proposal development and submission.

D.3.2 Oral Defense of Proposal

Every student is required to defend their Written Thesis Proposal to their TPC in the form of a 45 minute oral presentation followed by brief questions from the public, followed by an additional 30-60 minutes of questions from the committee. The oral defense should take place no later than the **end of the second summer.** The written Thesis Proposal should contain (1) a review of the literature of their field; (2) a discussion of how the proposed research fits into that field; (3) a summary of preliminary results; (4) a description of the planned work and primary aims of the thesis. Each TPC member (except for the supervisor) is expected to ask questions designed to probe the students' understanding of their proposed research. It is the responsibility of the TPC to decide if the student "passes" or "fails" the Thesis Proposal – judged comprehensively based on the quality of the written and oral components. A student who passes is formally admitted to Ph.D. candidacy.

D.3.3 Procedures for Re-examination of the Proposal

A student who fails must rewrite his/her Thesis Proposal and/or repeat the oral presentation as directed by their TPC. The re-examination must occur no later than the semester subsequent to the initial exam. A student who fails his/her examination twice will be removed from the program.

D.4 Yearly Thesis Review

The student should meet with his/her Thesis Reading Committee on at least a yearly basis to review research progress. Students are required to complete an annual progress update that is due at the start of each subsequent fall semester or upon graduating and will be distributed electronically.

D.5 Ph.D. Thesis defense

D.5.1 Procedures prior to the defense

Institute-Required Forms: To complete its records for each Ph.D. student, the Registrar's Office requires an *Online Application for Graduation*, which must be submitted to the Registrar's Office prior to the student's final semester. The exact date is listed in the official school calendar by semester.

Enrollment Status: The student must be registered during the semester in which the final presentation occurs. A student must also be registered the semester he/she plans to graduate unless an enrollment waiver is requested and approved. An enrollment waiver will not be approved if the Thesis has not been accepted by the Graduate Studies Office by the published deadline.

Thesis Documents: The Ph.D. proposal presentation consists of (1) a proposal document and (2) an oral presentation and examination evaluated by the Ph.D. Thesis Reading Committee. The proposal document must be received by the members of the thesis committee at least two full weeks prior to the oral presentation and examination. The student should contact each committee member to arrange the delivery of the proposal in either hard-copy or electronic format.

Scheduling**:** The student must poll the committee and establish a date and time for the presentation, reserve a room and prepare an announcement of the presentation. The student is responsible for reserving the room and obtaining the necessary audio-visual equipment prior to the oral presentation. Some faculty have extremely busy schedules, and this step should be done at least 6 weeks in advance to ensure faculty availability.

D.5.2 Procedures During the Defense

The thesis defense includes an oral presentation of the findings of the thesis, questions from the audience and the committee, and a closed Q&A with the student and the thesis reading committee (TRC). After successful public defense of the Thesis, the candidate prepares a final manuscript incorporating the modifications required by the Thesis Committee. After obtaining approval signatures from the Thesis Committee and the Director of QBioS, the candidate should follow the electronic submission, printing and distribution specified online.

E. Stipend, Duties, Registration & Fees

E.1 Home School

The QBioS Graduate Program is one of Georgia Tech's few interdisciplinary graduate programs. It is independent of any particular school or department and is supported by the College of Sciences. Participating academic units are called Home Schools.

The participating Home Schools in QBIOS include the Schools of Biological Sciences (SoBS), Chemistry and Biochemistry (CHEM), Earth and Atmospheric Sciences (EAS), Mathematics (MATH), Physics (PHYS) and Psychology (PSYC).

Home Schools admit students to QBioS and set administrative policies for students in that Home School (such as stipend policies). Home Schools do not administer degree requirements, such as thesis proposal evaluation, approval of programs of study, and procedures related to dissertation committee selection and defense. Home Schools cannot alter any programmatic requirements.

The Home School of the student, as well as the student's research advisor (if a different Home School), also set policies regarding laboratory and research infrastructure: examples include office space, mail boxes, faxes, photocopying, travel rules, vacation policies, etc. The Home School is also responsible for the administration of tuition waivers.

Faculty may apply for QBioS membership if they have at least a 25% FTE appointment in any of the participating Schools. Program faculty may advise QBioS students in any home school.

E.2 Financial Support

All issues of financial support are a matter between the Home School and the student. Please follow your Home School's policies regarding forms and deadlines to avoid any discontinuation of support. This is especially important if your Home School is not that of your advisor.

Typically, students are supported via a GTA in the fall and spring of their first year and via a GRA in the summer of their first year. Subsequent support is provided by a combination of GRAs, GTAs and fellowships. Three types of financial aid are available to qualified graduate students:

1. GRA/GTAs (Graduate Research Assistantships/Graduate Teaching Assistantships).
These are awarded on the basis of academic potential and performance and not on the basis of need. They are awarded either at the time of your offer of admission or by a faculty member wishing to support you in his/her laboratory as a GRA. Please note: If you were not admitted with financial support, the last day a student can be placed on a GRA for the semester is the last day of the first week of classes. After this date, even if a professor wishes to financially support a student, the student cannot be supported as a GRA until the following semester. In this interim period, the student may be supported as an hourly employee, but will not be eligible for a tuition waiver and will have to pay all relevant fees and tuition.

2. External Fellowships. Students are highly encouraged to apply for external fellowships such as NSF, NDSEG, Department of Energy, Department of Homeland Security, and NIH NRSAs. Most of these are only available to US citizens and permanent residents. A web page describing many of these opportunities is located at http://www.grad.gatech.edu/fellowships.

3. Out-of-state Tuition Waivers. Waivers are only awarded to Ph.D. students based on a nomination by the student's Home School. Out-of-state Tuition Waivers are not guaranteed to students, and are typically reserved for students supported by externally funded fellowships and

training grants. GRAs and GTAs do not need to obtain an out of state tuition waiver; tuition is covered by virtue of being a GRA/GTA.

E.3. Assistantship Duties

Typically, a GTA works for the Home School for 9-12 hours/week. A student may be asked to (a) supervise undergraduate laboratories, (b) proctor examinations, (c) grade homework, or (d) tutor undergraduates. A GRA works as part of an individual professor's research team. A student's duties are to conduct research toward a student's Ph.D. GRA salaries are paid from the research grants of individual professors. Therefore, once a student is committed to a professor for a student's Ph.D., a student must ask him/her before registering each semester to learn whether he or she will be a GRA or a GTA for the coming semester.

E.4 Registration

E.4.1 General Issues

Not long after mid-term every semester, Phase I registration opens for the next semester. It lasts two weeks. Phase II registration opens just before each semester begins. It also lasts two weeks. **Plan to register during Phase I.** Note: even if a student registers during Phase I, he/she does not need to pay the registration fee until the beginning of Phase II. During Phase I in the spring, students can register for both summer and fall classes. The registration web site is https://oscar.gatech.edu. **There is no reprieve for forgetting to register** – you will not be eligible to be paid as a GRA and will be responsible for paying all tuition and fees for the following semester. The Registrar is strict with respect to fee payment and registration deadlines. Registration dates are available online: http://www.registrar.gatech.edu/registration/calendar.php. See Appendix C for sample registration during Year 1.

E.4.2 Cross-registration

Graduate students may cross-register for courses at other Atlanta-area universities, such as Emory University and Georgia State University, via the Atlanta Regional Consortium for Higher Education (ARCHE). You must be a full-time student in good academic standing at the time of application in order to cross-enroll. The deadline for cross-enrollment is part-way through the semester preceding he intended enrollment semester, so plan ahead. More information is available online at https://registrar.gatech.edu/registration/cross-registration. You should receive a notification by email if your cross-enrollment request is approved. Ph.D. students can simply apply such courses to their Program of Study subject to approval of the Graduate Committee.

E.5 Fees

GTA and GRA students must pay mandatory student fees during every semester of enrollment (fall, spring, and summer). Ph.D. students without any financial support pay both tuition and mandatory student fees for every semester of enrollment. The tuition and fees for students not on GTA or GRA vary based on the number of hours registered, as well as the student's residency status (Georgia resident or non-resident). The complete fee schedule is posted at http://www.bursar.gatech.edu. Students can pay on-line or in person at the Office of the Bursar. **Pay student fees on time to avoid late charges!**

F. Facilities

F.1 E-Mail & Telephones

The Program and the Institute communicates with students thourough an e-mail account that is assigned to each student. **It is essential that a student activate this account and check it every business day.** Students can do this at https://mail.gatech.edu/GTpreauth/. We do not provide phones in student offices. Students may use the phones in the QBioS program office for emergency outgoing calls. However, the front office does not pass on telephone messages to students. Students actively engaged in research may have access to phones in the research space of their advisors. If so, outgoing calls must be restricted to professional matters.

F.2 Mailboxes

Students have personal mailboxes in Cherry Emerson – please check these on a regular basis. The mailing address is:
School of Biological Sciences, Georgia Institute of Technology Atlanta, GA 30332-0230

F.3 Office Space

In their first year, students will be assigned a desk in a shared office space in the Cherry Emerson building with other first-year QBioS students. At the end of their first year, they will move to a desk given to them by their thesis advisor.

F.4 Room Access

A first-year student's Buzz Card opens the exterior doors of the Cherry Emerson building. A student's key or Buzz Card opens a student's office, the mailroom, the computer cluster (S021), and two rooms on the second floor (common room, library). Books and journals from the library can be removed for photocopying only.

F.5. Travel Funds

The Director maintains a small fund to support graduate student travel to professional conferences. A student may apply for these funds *once* during his/her time at Georgia Tech. To apply, send a brief letter of request, endorsed by the student's research supervisor, to the Director stating what a student intends to do and the projected cost. The Graduate Student Senate also has a fund to support professional travel. Apply directly to them: http://sga.gatech.edu/g/conference-fund/.

F.6 Security

Our campus is in an urban environment. Take special care if walking in the adjacent neighborhoods after dark. Security on the campus and inside buildings is very good. We need students' help to keep it that way. All persons who have reason to be in a building at night or on weekends have a key. Therefore, there is never any reason to let a person in. Never prop open a door to allow people to enter. Always lock office doors. Anyone who steals the private property of another person (or of the School itself) will be dismissed from the program. If a student ever finds unauthorized persons in a GT building, open doors, or unusual activities, report them to the campus Police (Ext 4-2500 or 404-894-2500) immediately.

G. Administrative Issues

G.1 Program Management

QBioS will be led by a program director with day-to-day operations handled by a program manager. The following sections describe the administrative structure along with responsibilities.

Program Director (PD)

The PD is responsible for overall program administration and policy directions. The founding PD for the Ph.D. in QBioS is Prof. Joshua S. Weitz (School of Biological Sciences) who can be reached regarding QBioS matters at: director@qbios.gatech.edu.

Program Manager (PM)

The PM handles most routine administrative aspects of the program (such as anything involving submitting a form or requesting approval) and coordinates admissions with the Home Schools. The current program manager is Lisa Redding and can be reached regarding QBioS matters at: admin@qbios.gatech.edu.

General Faculty

This includes all faculty who participate in the QBioS program. They approve all general policies and meet regularly each semester. Faculty meetings have a quorum requirement for voting: a quorum is defined as 33% of the number of faculty actively participating in the program. See Appendix A for a current listing of QBioS program faculty.

Graduate Studies Committee

The Graduate Studies Committee oversees the operation of QBioS. The committee has responsibility for all graduate-level degree requirements, approval of Ph.D. Programs of Study forms in which transfer credit from another institution is requested and oversight of the Ph.D. thesis proposal process. A student may petition the Graduate Studies Committee regarding academic issues by submitting a petition detailing his/her request to the QBioS Program Chair. The committee meets monthly during the academic year. Members of this committee are appointed by the QBioS Program Director, who chairs the committee. The current members of the graduate studies committee are:

Joshua Weitz (Chair, SoBS), Bridgette Barry (CHEM), Sam Brown (SoBS), Jennifer Curtis (PHYS), Chouristine Heitsch (MATH), Takamitsu Ito (EAS), Harold Kim (PHYS), Simon Sponberg (PHYS), Matthew Torres (SoBS).

G.2 Counseling Center

Graduate school is a life changing event, and the path is not always easy. The Counseling Center at Georgia Tech provides individual and group counseling, workshops on such topics as stress management and study skills, career counseling and psychological testing. The Center is staffed by licensed psychologists, counselors, and marriage and family therapists, as well as counselors-in-training. The Counseling Center can be reached at 404-894-2935, or you can learn more online at http://www.counseling.gatech.edu.

G.3 Transfer into the QBioS Ph.D. program

Students seeking to transfer from their current major into the QBioS Graduate program will need to first meet the minimum GPA requirement of 3.0 and submit a narrative explaining why they wish to change to the QBioS major. Secondly, students will need a letter of endorsement from their current thesis advisor. Finally, students must not have failed their current major's qualifying exam. Students who have failed their current major's qualifying exam will not be considered for transfer into the QBioS graduate program. If the above conditions are satisfied, students will need to submit a change of major form that has been signed by the home school authorizing the change of major to the QBioS graduate office. These documents are then reviewed by the Chair of the QBioS graduate program as well as the QBioS Graduate Studies Committee for final approval. Students will then be notified whether they will be allowed to transfer into the QBioS program.

G.4 Changing Home Schools

QBioS allows students in any Home School to pair with advisors in any Home School. Students are bound by the administrative policies of the Home School of the student. In some cases, students may wish to change their home school; the most common scenario is to change into the Home School of the advisor. Changing Home Schools requires the consent of the student's thesis advisor as well as the graduate office of the proposed Home School. A Change of Major form is used to facilitate this change. Contact the administrative manager of QBioS for more information: admin@qbios.gatech.edu.

G.5 Changing Thesis Advisors

A student seeking a change of advisor must first discuss the matter with his/her current advisor and satisfactorily complete all GRA and research obligations. The Program Chair must be involved in these discussions to ensure that all parties' needs and obligations are met. Upon satisfactory completion of these obligations the current advisor will then "release" the student by signing a "Change of Advisor" form. This form is then submitted to the QBioS graduate office for approval.

Appendix A. Program Faculty

Faculty Name	Rank	Home School	Academic Discipline	Area of Specialization (up to 5)
Ed Balog	Associate Professor	SOBS	Physiology	Skeletal and Cardiac Muscle Excitation-Contraction Coupling, Ryanodine Receptors
Bridgette Barry	Professor	CHEM	Biophysical Chemistry	Mechanisms of electron and proton transfer, photosynthesis, DNA synthesis, biomimetics, spectroscopy
Annalisa Bracco	Professor	EAS	Physical Oceanography and Climate Dynamics	Geophysical fluid dynamics, transport and mixing in the ocean, bio-physical interactions in the ocean, climate dynamics, modeling
Sam Brown	Associate Professor	SOBS	Evolutionary Biology	Social evolution, mathematical biology, quorum sensing, virulence, experimental microbiology
Leonid Bunimovich	Regents' Professor	MATH	Mathematical Biology & Ecology	Dynamical networks, Dynamical and Stochastic Systems

Young-Hui Chang	Professor	SOBS	Physiology	Locomotion, aeromechanics, motor control, neurophysiology
Jennifer Curtis	Associate Professor	PHYS	Biophysics	Cell mechanics, molecular biophysics, bio nanotech, optical manipulation
Stephen Diggle	Associate Professor	SOBS	Microbiology	Social evolution, quorum sensing, biofilms, infection, antimicrobial resistance
Emanuele Di Lorenzo	Professor	EAS	Ocean and Climate Science	Modeling Geofluid Dynamics, Marine Ecosystem Dynamics, Climate Variability & Change, Inverse and Statistical Modeling
Audrey Duarte	Associate Professor	PSYC	Cognitive Neuroscience	Memory, aging, fMRI, EEG
Flavio Fenton	Professor	PHYS	Computational/ Experimental Biophysics	Complex systems, pattern formations, physics of living systems
Neha Garg	Assistant Professor	CHEM	Human Microbiome	Metabolomics, Microbial Imaging Mass Spectrometry, Natural Product Biosynthesis, Chemical Biology, Biochemistry
Jennifer Glass	Assistant Professor	EAS	Biogeochemistry	Geochemistry, environmental microbiology, greenhouse gas cycling
Daniel Goldman	Professor	PHYS	Experimental nonlinear dynamics	Nonlinear dynamics, behavior, robotics, granular media
Michael Goodisman	Associate Professor	SOBS	Social Biology	Evolution, Ethics, Genomics, Animal Behavior
James Gumbart	Associate Professor	PHYS	Computational Biophysics	Membrane proteins, ribosome, molecular dynamics
Brian Hammer	Associate Professor	SOBS	Microbiology	Bacterial genetics, signal transduction, small RNAs, Vibrio biology, biofilms
Mark Hay	Professor	SOBS	Community Ecology	community ecology, chemical ecology, marine and aquatic ecology
Christine Heitsch	Professor	MATH	Discrete Mathematics	Discrete mathematical biology, RNA secondary structure, combinatorics
Christian Houdre	Professor	MATH	Probability Theory and Statistics	Probability theory and applications, aspects of mathematical finance, bioinformatics and statistics
David Hu	Associate Professor	SOBS & ME	Fluid Dynamics	Biofluidics, nonlinear dynamics, locomotion, behavior
Nicholas Hud	Professor	CHEM	Biophysical Chemistry	Nucleic acid structure, function and evolution.
Takamitsu Ito	Associate Professor	EAS	Oceanography	Computational modeling of climate and biogeochemical processes
Lin Jiang	Professor	SOBS	Community Ecology	Biodiversity, community assembly, phylogenetic community ecology
Wendy Kelly	Associate Professor	CHEM	Chemical Biology	Chemical biology, natural products chemistry, natural products biosynthesis, biochemistry, drug discovery
Harold Kim	Associate Professor	PHYS	Experimental/ Computational Biophysics	Molecular biophysics and genetics

Joel Kostka	Professor	SOBS	Microbial Ecology	Environmental microbiology, microbial ecology, microbiomes, bioremediation, climate change
Julia Kubanek	Professor	SOBS & CHEM	Chemical Biology	Chemical ecology; chemical signaling; natural products chemistry; metabolomics; drug discovery
Rachel Kuske	Professor	MATH	Stochastic Nonlinear Dynamics	Stochastic nonlinear dynamics; mathematical neuroscience, biochemical reactions, nonlinear transitions, environmental dynamics
Joe Lachance	Assistant Professor	SOBS	Population Genetics	Darwinian medicine, evolutionary genomics, human genetics, molecular evolution, theoretical population genetics
Raquel Lieberman	Professor	CHEM	Biophysical Chemistry	Membrane proteins, protein misfolding, chemical biology, macromolecular crystallography
Jean Lynch-Stieglitz	Professor	EAS	Oceanography	Ocean circulation and climate, isotope geochemistry
Elisabetta Matsumoto	Assistant Professor	PHYS	Geometry of Materials	Soft matter physics, geometry, mechanics, soft materials, applied mathematics
Patrick McGrath	Associate Professor	SOBS	Personal Genetics	Quantitative Genetics, Behavior, GPCR-ligand binding, Epistasis
Jenny McGuire	Assistant Professor	SOBS	Spatial Ecology and Paleontology	Spatial ecology, paleontology, climate change, ecological modeling, terrestrial systems
Richard Nichols	Professor	SOBS	Physiology	Motor control, spinal cord physiology, biomechanics
Shuyi Nie	Assistant Professor	SOBS	Cellular Biology	Cellular mechanics, cytoskeletal regulation, cell-matrix interactions
Annalise Paaby	Assistant Professor	SOBS	Evolutionary Biology	Genomics, quantitative genetics, experimental evolutionary biology
Boris Priloutski	Professor	SOBS	Physiology	Sensory control of locomotion, peripheral nerve injury, osseointegrated limb prostheses, artificial sensory feedback, neuromechanical modeling
Will Ratcliff	Assistant Professor	SOBS	Evolutionary Biology	Major transitions in evolution (mainly multicellularity). The evolution of cooperation. Bet hedging / evolution in fluctuating environments. The evolution of aging. Life cycle evolution.
Chris Reinhard	Assistant Professor	EAS	Biogeochemistry	Biogeochemistry, Planetary Science, Paleoceanography
Greg Sawicki	Associate Professor	SOBS & ME	Human Physiology of Wearable Robotics	Terrestrial Locomotion, Neuromechanics, Wearable Robotics, Human Augmentation, Elastic Mechanisms
Jeffrey Skolnick	Professor	SOBS	Systems Biology	Computational Systems Biology, Bioinformatics, Drug Discovery, Protein Structure Prediction
Simon Sponberg	Assistant Professor	SOBS & PHYS	Experimental Biophysics	Neuromechanics, dynamics of locomotion, multiscale physics of muscle

Frank Stewart	Associate Professor	SOBS	Microbial Biology	marine microbial ecology and evolution, microbial symbioses, genomics and metagenomics, microbiology of oxygen minimum zones
Alberto Stolfi	Assistant Professor	SOBS	Developmental Neurobiology	Developmental biology, neuroscience, cell biology, gene regulation, genome engineering
Todd Streelman	Professor	SOBS	Evolutionary Biology	genomics, development, behavior
Matthew Torres	Associate Professor	SOBS	Proteomics	Protein Biology and Biochemistry; Cell Signaling; Mass Spectrometry; Proteomics
Joshua Weitz	Professor	SOBS	Theoretical Ecology	Viral ecology and evolution, nonlinear dynamics, network science, physics of living systems
Lewis Wheaton	Associate Professor	SOBS	Physiology	Neurophysiology guiding skillful human-object interactions in upper extremity motor control.
Marvin Whiteley	Professor	SOBS	Microbial Communities	Microbiology, genomics, infectious disease, antimicrobial resistance, sociomicrobiology
Kurt Wiesenfeld	Professor	PHYS	Nonlinear Dynamics	Theoretical modeling of nonlinear and stochastic systems
Loren Williams	Professor	CHEM	Evolution and Chemical Biology	Origins and Evolution of the Ribosome
Yao Yao	Assistant Professor	MATH	Nonlinear Dynamics	Fluid dynamics, nonlinear dynamics, swarms, asymptotic theory, continuum dynamics
Soojin Yi	Professor	SOBS	Molecular Evolution	Genome Evolution, Epigenomics, systems biology
Peter Yunker	Assistant Professor	PHYS	Soft Matter Physics	Mechanics of hierarchical materials, biomechanics, biomaterials, cell packings

Appendix B. Course Listings

The following lists courses eligible for inclusion in a Program of Study. Note that course syllabi are maintained and updated by Professors on a regular basis. Please check with the individual home school for more information. All courses are 3 credit hours unless otherwise noted. Course times and locations are subject to change.

Core Introductory Courses

All of these courses are required for students in the program. Foundations in Quantitative Biosciences will be offered every fall semester. The fall section of BIOL 8801 will include seminars from current QBioS faculty. The spring section of BIOL 8801 will allow students to attend existing seminar courses of their choosing, related to Quantitative Biosciences.

CORE1.	BIOL 8804 or 8814	Foundations of Quantitative Biosciences (4 hours)
CORE2.	BIOL 8801	Seminar in Biology – Quantitative Biosciences (1 hour)
CORE3.	BIOL 8801	Seminar in Biology – Quantitative Biosciences (1 hour)

Quantitative Models in the Biosciences (3 hours)

The following courses satisfy the requirement that students take a single course involving the direct application of quantitative methods to the biosciences. All courses are 3 credit hours, including problem sets, involving mathematical and computational methods.

QBIO1.	BIOL 4225/7111	Molecular Evolution
QBIO2.	BIOL 6422	Theoretical Ecology
QBIO3.	BMED 4477	Biological Networks and Genomics
QBIO4.	CHEM 6571	Enzymology and Metabolism
QBIO5.	EAS 6122	Global Biogeochemical Cycles
QBIO6.	EAS 6490	Advanced Environmental Analysis
QBIO7.	ISYE 6404	Nonparametric Statistics
QBIO8.	MATH 6705	Modeling and Dynamics
QBIO9.	PHYS 8803	Biophysics

Bioscience Electives leverage pre-existing courses in CoS (6 hours).
Committee can grant permission to take additional courses satisfying these requirements.

Molecular and Cellular Systems Courses

MCS1.	BIOL 6608	Prokaryotic Molecular Genetics
MCS2.	BIOL 7110/ CHEM 8901	Macromolecular modeling (4 hours)
MCS3.	BIOL 7668	Eukaryotic Molecular Genetics
MCS4.	CHEM 6572	Macromolecular structure
MCS5.	CHEM 6573	Molecular biochemistry
MCS6.	CHEM 6582	Biophysical chemistry
MCS7.	PHYS 8803	Biophysics

Chemistry of Biological Systems Courses

CHEB1.	BIOL 6418	Microbial Physiology
CHEB2.	BIOL 6611	Advanced Microbial Physiology
CHEB3.	CHEM 6501	Biochemistry I
CHEB4.	CHEM 6502	Biochemistry II
CHEB5.	CHEM 6571	Enzymology & Metabolism
CHEB6.	CHEM 6582	Biophysical Chemistry
CHEB7.	CHEM 6756 & BIOL 6756	Signaling Molecules

Physiology and Behavior Courses

BPH1.	APPH 6212	Systems Physiology II: Physiology of Neuromotor Tissues
BPH2.	APPH 6213	Systems Physiology III: Integrated Systems and Adaptation
BPH3.	APPH 6231	Human Motor Control
BPH4.	APPH 6236	Neuromuscular Physiology
BPH5.	APPH 6400	Human Neuroanatomy
BPH6.	APPH 6600	Muscle Structure & Plasticity
BPH7.	BIOL 6570	Immunology and Immunochemistry
BPH8.	BIOL 6626	Animal Physiology
BPH9.	PSYC 6011	Cognitive Psychology

Ecology Courses

ECO1.	BIOL 6410	Microbial Ecology
ECO2.	BIOL 6417	Marine Ecology
ECO3.	BIOL 6422	Theoretical Ecology
ECO4.	BIOL 6620	Aquatic Chemical Ecology
ECO5.	BIOL 8802	Special Topics in Community Ecology (2 hours)
ECO6.	BIOL 8803	Environmental Microbial Genomics
ECO7.	BIOL 8803	Microbial Symbiosis

Evolution Courses

EVO1.	BIOL 7111	Molecular Evolution
EVO2.	BIOL 6480	Developmental Biology (2 hours)
EVO3.	BIOL 4545	Human Genetics
EVO4.	BIOL 6600	Evolution
EVO5.	BIOL 6720	Environmental Microbial Genomics
EVO6.	BIOL 7210	Computational Genomics

Earth Systems Courses

ES1.	EAS 6122	Biogeochemical Cycles
ES2.	EAS 6130	Earth System Modeling
ES3.	EAS 6136	Paleoclimatology & Paleoceanography
ES4.	EAS 6490	Advanced Environmental Data Analysis
ES5.	BIOL 6410	Microbial Ecology
ES6.	BIOL 6221	Biological Oceanography
ES7.	BIOL 6765/EAS6765	Geomicrobiology

Quantitative Modeling courses (9 hours)
The following courses satisfy the requirement that students take a course involving rigorous quantitative methods and models. Any MATH 6xxx, 7xxx or 8xxx course is eligible for this requirement, as are many courses in the Colleges of Science, Computing, and Engineering. We include a few representative courses below.

QM1.	APPH 6225	Biostatistics
QM2.	CHEM 6481	Statistical Mechanics
QM3.	CHEM 6755	Theoretical Chemistry of Polymers
QM4.	CHEM 8843	Mathematical Methods for Chemistry
QM5.	CS 7492	Simulation of Biology
QM6.	CS 7641	Machine Learning
QM7.	CSE 6140	Computational Science and Engineering Algorithms
QM8.	CSE 6220	High Performance Computing
QM9.	CSE 6301	Algorithms for Bioinformatics and Computational Biology
QM10.	CSE 6643	Numerical Linear Algebra
QM11.	CSE 6730	Modeling and Simulation: Fundamentals and Applications
QM12.	CSE/ISYE 6740	Machine Learning I: Computational Data Analysis
QM13.	EAS 6502	Introductory Fluid Dynamics
QM14.	EAS 8803	Mathematical Methods for Geophysical Fluid Dynamics
QM15.	ISYE 6404	Nonparametric Data Analysis
QM16.	ISYE 6421	Biostatistics
QM17.	MATH 6221	Advanced Classical Probability Theory
QM18.	MATH 6705	Modeling and Dynamics
QM19.	PHYS 6124	Mathematical Methods for Physics
QM20.	PHYS 6268	Nonlinear Dynamics and Chaos
QM21.	PHYS 7123	Nonequilibrium Statistical Physics

One course in quantitative modeling may be taken at the 4xxx level. A few representative courses include:

QM*.	CS 4641	Machine Learning
QM*.	MATH 4221	Stochastic Processes I
QM*.	MATH 4280	Introduction to Information Theory
QM*.	MATH 4541	Dynamics and Bifurcations I

Appendix C. Sample Course Registration

Fall Semester, Year 1
BIOL 8801, Seminar in Quantitative Biosciences = 1 hour
BIOL 8804 or 8814, Foundations of Quantitative Biosciences = 4 hours
BIOL 8901 WTZ, Special Problems = 1 hour
Quantitative Modeling Course = 3 hours
Biosciences Elective = 3 hours
Your home school may have requirements such as:

- BIOL or PHYS 8997, 3 audit hours, identifies GTA students
- BIOL or PHYS 8998, 3 audit hours, identifies GRA students
- CETL 8000 (Sections BIO or PH1), TA training

Spring Semester, Year 1
BIOL 8901, Rotation 1 (Advisor Section) = 3 hours
BIOL 8901, Rotation 2 (Advisor Section) = 3 hours
BIOL 8901 JSW = 1 hour
BIOL 8801 = 1 hour
BIOL 8998 WTZ (or GRA Advisor) = 3 hours
Biosciences Elective = 3 hours
BIOL 8106 (Tools of Science, RCR requirement) = 2 hours

Summer Semester, Year 1
BIOL 8901 or 8902 or 9000 (Advisor Section) = 12 hours
PHIL 6000 = 1 hour (if you haven't taken PHIL 6000 or BIOL 8106)
Academic Writing Course

- CETL 8721 = 1 hour (native English speakers)
- CETL 8723 = 2 hours (non-native English speakers)

BIOL 8998 WTZ = 3 hours (can reduce to 2 or 1 hour if needed for 16-hour cap)