GRADUATE HANDBOOK 2016-2017
INTERDISCIPLINARY QUANTITATIVE BIOLOGY PHD
CERTIFICATE IGERT PROGRAM*

University of Colorado, Boulder
Phone: 303-735-7508
IQBiology.colorado.edu

Updated August 2016

*Generously supported by NSF IGERT Grant number 1144807.
BioFrontiers

The University of Colorado BioFrontiers Institute drives innovation without boundaries. At BioFrontiers, researchers from the life sciences, physical sciences, computer science and engineering are working together to uncover new knowledge at the frontiers of science, and partnering with industry to make their discoveries relevant.

IQ Biology

The Interdisciplinary Quantitative Biology (IQ Biology) program is the graduate education arm of this interdisciplinary institute and focuses on preparing researchers from multiple disciplines to work together on questions in quantitative biology and to become leading interdisciplinary researchers.

(Cover image: Imaging RNA molecules within the cellular environment can be a challenging process. Here, the nucleus is stained with DAPI (blue), and specific RNA molecules are labeled (green). The unique sub-cellular distribution of this particular RNA, being both cytoplasmic and the nucleolar, provides immediate insight into the cellular biology.)
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Section I:

IQ Biology PhD Certificate IGERT Program

Interdisciplinary Quantitative Biology (IQ Biology) graduate students have access to world-class educators and colleagues across many different disciplines and departments. Our goal is to develop students who can reach across a wide range of disciplines, work with multiple experts, and think fearlessly.

(IGERT grant # NSF 11448017)
An Introduction to IQ Biology

As an IQ Biology student you will be an integral member of the BioFrontiers community that is dedicated to tackling the quantitative challenges of modern bioscience. The mountains of data generated by new technologies demand that scientists be skilled in mathematical and computational analysis while knowledgeable of biological systems and experimental methods. BioFrontiers scientists work together to transform mountains of data into knowledge and use it to discover and develop methods and tools, and deliver real-world solutions.

The IQ Biology program seeks to attract a talented, diverse and inquisitive cohort. In collaborative, quantitative biology, scientists from array of backgrounds come together to form a team with sufficient biological, computational, and mathematical knowledge to fully assess modern scientific problems.

We seek applicants who have demonstrated strong ability in one field and who exhibit interdisciplinary curiosity through solid experience in a secondary field (through a minor discipline or through research or work experiences). Once enrolled, you will be encouraged to achieve greater knowledge in your primary field of study, expand your familiarity with a secondary discipline and further explore a third.

Upon graduation, IQ Biology students receive a certificate in Interdisciplinary Quantitative Biology in addition to a disciplinary PhD. The certificate program requires students to fulfill specific requirements, designed to ensure that students, in addition to their disciplinary ability, demonstrate fundamental competencies in mathematics, computation, and biology. The program requirements are distinct from those stipulated by doctoral degree programs; however, formal agreements between IQ Biology and the participating departments minimize time to degree.

Our Departmental Partners are:
- Applied Mathematics
- Chemistry and Biochemistry
- Chemical and Biological Engineering
- Computer Science
- Ecology & Evolutionary Biology
- Geology
- Material Science and Engineering
- Mechanical Engineering
- Molecular, Cellular, & Developmental Biology
- Physics

(Please contact IQ Biology staff if you are interested in a degree program not listed here.)

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Program Overview

Generously supported by the US National Science Foundation (NSF) through the IGERT program, the IQ Biology certificate program allows you to explore coursework and research across academic departments. You work in interdisciplinary teams as you develop your thesis ideas and before diving into specific degree program requirements. The IQ Biology program is designed to provide you with disciplinary depth, multidisciplinary knowledge and transdisciplinary skills.

Essential program elements include:

- First year coursework
  - Three core courses that all students must take
  - “Gap filling” courses chosen by the student in consultation with the Academic Advising Committee
- Laboratory rotations (three rotations chosen by the student in a minimum of two departments)
- Idea Exchanges
- Seminars
- Student Symposia held every other year
- Internship, outreach, and teaching opportunities

Students already accepted at CU are welcome to participate in the IQ Biology program; however, the prototypical path of entry to the IQ Biology program is for students, not yet enrolled, to apply simultaneously to the IQ Biology program and to as many as three disciplinary PhD programs.

Upon acceptance to IQ Biology, students enroll at CU Boulder as IQ Biology students with “preapproval” in two or more PhD programs. The focus of this first year as an IQ Biology student is to develop interdisciplinary knowledge and thinking. After completing the first year, students choose a PhD mentor and decide which degree program to join.

After joining a departmental program, IQ Biology students are expected to remain engaged and take on leadership roles within the IQ Biology program by:

- Joining the Student Leadership Council
- Running the IQ Biology Student Symposium
- Organizing Idea Exchange discussions
- Presenting at the Data Science Supergroup
- Attending IQ Biology seminars
- Applying for funding to participate in interdisciplinary meetings and visits with collaborators
- Competing for IQ Biology Innovation Awards
- Interacting regularly with their interdisciplinary mentor and IQ Biology colleagues
- Fulfilling interdisciplinary requirements for their dissertation research
• Serving as a peer mentor

The checklist on the following page summarizes the program requirements on a year-by-year basis. A detailed checklist is available in Appendix A.
IQ Biology Summary Checklist:

**Course Requirements**

**FIRST YEAR FALL SEMESTER**
- [ ] Core Course: Quantitative Optical Imaging (4 credit hours)
- [ ] First IQ Biology Research Rotation (3 credits)
- [ ] 1st Gap-Filling Course (3 credits)

**FIRST YEAR SPRING SEMESTER**
- [ ] Core Course: Bioinformatics and Genomics (4 credit hours) OR Manual Lladser Mathematical and Computational Biology (4 credit hours)
- [ ] Core Course: Cells, Molecules and Tissues, a Biophysical Approach (3 credit hours) OR Biophysics (4 credit hours)
- [ ] 2nd and 3rd IQ Biology Research Rotations (3 credit hours)
- [ ] 2nd Gap-Filling Course (3 credit hours) (optional)

*All domestic graduate students must file for residency with the university.*

http://www.colorado.edu/registrar/state-tuition

**COMPLETE BY END OF 2ND YEAR**
- [ ] Ethics Course or Workshop

**Research Requirements**
- [ ] Three 10-week research rotations
- [ ] Choose Degree Program and Research Advisor
- [ ] Annual Dissertation Committee Meetings
- [ ] Dissertation (with demonstrated interdisciplinary focus)

**Activity Requirements**
- [ ] Three IQ Biology Academic Advising Meetings
- [ ] Weekly IQ Biology Idea Exchange
- [ ] IQ Biology Seminar Series
- [ ] Data Science Supergroup
- [ ] IQ Biology Symposium
- [ ] Outreach
- [ ] Teaching (optional)
- [ ] Internship (optional)

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IQ Biology Curriculum

Goals of the Curriculum

While students can choose from a number of disciplines, they are expected to demonstrate competency in a number of key foundational areas (see Table 1: List of IQ Biology Key Foundational Areas). Students will address two of the Bioscience subject areas and two of the Quantitative Science subject areas through previous degrees, gap-filling coursework, rotations or thesis research. Because of the inherent interdisciplinary focus of each student’s studies and research, some of these topics may integrate multiple departments (e.g., “network analysis” could be addressed in courses and research in Applied Mathematics, Computer Science, or Ecology and Evolutionary Biology); the IQ Biology Academic Advising Committee guides students and balances coursework with student needs.

Through the IQ Biology curriculum, students are also exposed to and made aware of specific core competencies (See Table 2: List of Core Competencies) that are demonstrated by knowledgeable and well-rounded researchers who collaborate effectively between disciplines. These competencies have been grouped into the areas of Biology Knowledge, Intellectual Processes, Innovation, Education, Communication, and Collaboration. As Table 2 indicates, these competencies may be attained through the program in a number of ways (including courses, lab rotations, and outreach activities).

As with any education program, coursework (see “Core Courses”) is a critical element. The first year provides IQ Biology students with a series of core courses that not only give students interdisciplinary breadth, but also teaches students to view specific biological problems in integrative ways and to understand the perspectives of and techniques used by scientists of a number of disciplines. These core courses serve as the foundation of the IQ Biology curriculum, and are augmented by two elective “gap-filling” courses that allow students to learn more in relevant areas to which they have been previously been minimally exposed.

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Table 1

List of IQ Biology Key Foundational Areas

<table>
<thead>
<tr>
<th>Major Fields</th>
<th>Subject Areas</th>
<th>Appropriate Topics</th>
</tr>
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<tbody>
<tr>
<td><strong>Bioscience</strong></td>
<td>♦ Biochemistry</td>
<td>• Biopolymers structure &amp; function</td>
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<td></td>
<td></td>
<td>• Signaling</td>
</tr>
<tr>
<td></td>
<td>♦ Cellular Biology</td>
<td>• Transcription/translation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Development</td>
</tr>
<tr>
<td></td>
<td>♦ Functional Genomics &amp; Evolution</td>
<td>• Genomes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Evolution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ecology/environmental science</td>
</tr>
<tr>
<td><strong>Quantitative Science</strong></td>
<td>♦ Applied Mathematics</td>
<td>• Stochastic process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Statistics &amp; probability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Linear algebra</td>
</tr>
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<td></td>
<td></td>
<td>• Differential equations</td>
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<td></td>
<td></td>
<td>• Optimization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Network analysis/graph theory</td>
</tr>
<tr>
<td></td>
<td>♦ Computer Science</td>
<td>• Information theory</td>
</tr>
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<td></td>
<td></td>
<td>• Algorithms and programming</td>
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<td></td>
<td></td>
<td>• Computational modeling</td>
</tr>
<tr>
<td></td>
<td>♦ Physics &amp; Optics</td>
<td>• Forces affecting bio-molecules</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Optics &amp; limits of microscopy</td>
</tr>
<tr>
<td></td>
<td>♦ Engineering</td>
<td>• Biomechanics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biotransport</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biomaterials &amp; tissue engineering</td>
</tr>
</tbody>
</table>

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*Back to Goals of the Curriculum*
Table 2  
List of IQ Biology Core Competencies

<table>
<thead>
<tr>
<th>Biology Knowledge</th>
<th>Process</th>
<th>Innovation</th>
<th>Education</th>
<th>Communication</th>
<th>Collaboration</th>
<th>Each core competency will be addressed in several ways:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Understand key biological concepts from populations to genes. 2,3</td>
<td>• Integrate knowledge from diverse fields. 1,2,5,6,7</td>
<td>• Creatively search for applications of research. 2,4,6,7,8,9</td>
<td></td>
<td></td>
<td></td>
<td>1. Interdisciplinary Cohort</td>
</tr>
<tr>
<td>• Infer relationships between biological scales (e.g., cells to tissues). 2,3</td>
<td>• Critically analyze previous research. 2,3,5,6,7</td>
<td>• Experience the process of implementing discoveries. 2,7,8,9,10</td>
<td></td>
<td></td>
<td></td>
<td>2. Core Coursework</td>
</tr>
<tr>
<td>• Quantify biological phenomena. 2,3,5,6</td>
<td>• Demonstrate understanding of problems verbally, visually and in writing. 2,6,7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Gap-filling Coursework</td>
</tr>
<tr>
<td>• Record images of biological phenomena. 2,3</td>
<td>• Organize a research plan, including developing experimental protocols. 1,4,5,6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4. Team Projects</td>
</tr>
<tr>
<td>• Infer physical and chemical principles to biological phenomena. 2,3</td>
<td>• Develop and test hypotheses. 1,4,5,6</td>
<td>• Embark on a path of continual learning throughout career. 1,2,3,8,10</td>
<td></td>
<td></td>
<td></td>
<td>5. Lab Rotations</td>
</tr>
<tr>
<td><strong>Quantitative Reasoning</strong></td>
<td>• Communicate results and conclusions. 2,5,6,7,8,10</td>
<td>• Share gained knowledge with researchers, students, and the general public. 1,6,7,8</td>
<td></td>
<td></td>
<td></td>
<td>6. Thesis Research</td>
</tr>
<tr>
<td>• Design models that describe biological phenomena. 2,3</td>
<td>• Determine limits of research. 2,6,7</td>
<td>• Generate a K-12 module that can be used in the US &amp; abroad. 2,4,8</td>
<td></td>
<td></td>
<td></td>
<td>7. Seminars/Symposia/Workshops</td>
</tr>
<tr>
<td>• Translate biological problems into mathematical equations and diagrams. 2,3,6</td>
<td>• Evaluate importance and validity of others’ research. 2,5,6,7</td>
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<td></td>
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<td></td>
<td>8. Outreach</td>
</tr>
<tr>
<td>• Predict biological phenomena under uncertainty using probabilistic model and statistical analyses. 2,3</td>
<td>• Demonstrate ethical research practices. 4,6,7,10</td>
<td></td>
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<td>9. Internships</td>
</tr>
<tr>
<td>• Assess statistical support for models and hypotheses. 2,3</td>
<td>• Recognize diverse career paths that utilize the skills they have acquired. 7,8,9,10</td>
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<td>10. Mentoring</td>
</tr>
<tr>
<td>• Engineer biomaterials or bioprocesses. 2,3</td>
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<tr>
<td>• Program algorithms to analyze biological data. 2,3,6</td>
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Course Work

Bootcamp

During bootcamp, IQ Biology students will engage in informal education sessions disguised to prepare students for the semester ahead and to build camaraderie amongst the members of the new class.

Bootcamp is open to all IQ Biology students, tutors, faculty and staff. The non-IQ Biology students enrolled in the Foundations of Quantitative Biology course are also invited.

Schedule for the orientation and bootcamp week

(All classes are taught in JSCBB B231 unless otherwise indicated):

**Friday, August 12, 2016: The 2016 BioFrontiers Symposium, 8:30 am – 5:00 pm**
Our scheduled speakers include some of the leading experts in these areas:

- **Gaudenz Danuser** (University of Texas-Southwestern)
- **Karl Deisseroth** (Stanford)
- **Michael Elowitz** (Caltech)
- **Sara Heilshorn** (Stanford)
- **Jean-Christophe Olivo-Marin** (Institut Pasteur)
- **Gerry Rubin** (HHMI-Janelia Research Campus)
- **Lani Wu** (UCSF)
- **Celeste Nelson** (Princeton)

**Monday 15 August 2016 [B115]**

- 7:30 AM-3:00 PM **Graduate School Breakfast and Orientation**
  @ Mary Rippon Theater with Breakfast, Lunch provided
  (We suggest bringing a snack)
- 3:00-3:20 PM **Intro to Bootcamp & IQ Biology**
- 3:20-4:30 PM **2nd year presentations (5 - 10 minutes)**
- **IT Help** (Printers, server access, Info on main campus storage, map network drive)

**Tuesday, August 16, 2016 - Optics, Microscopy, MATLAB [B115]**

- 9:00-11:00 **New Student Presentations**: 5-10 minutes
- 11:00-12:00 **Introduction to Optics** (Felix)
- 12:00-1:00 PM **Lunch**
- 1:00-2:00 **Microscopy 101 - Introduction to Microscopes with Joe**
- 2:00-4:00 **MATLAB Basics with Taisa and Cierra**
- 4:00 - 4:30 PM **Wrap-up discussion, what was learned, and lingering questions.**
- 4:30 - 5:30 **Happy Hour!**

**Wednesday, August 17, 2016 - CS and Math [B115]**

- 09:00-10:30 **Markov Chains/Process with Jacqui**
- 10:30-12:00 **Ordinary Differential Equations (ODEs) with Taisa**
- 12:00-1:00 **Lunch**
- 1:00-4:00 **Microscopy Training (4/5 students each, 2 rounds)**
  **MATLAB image analysis project**
4:00-4:30 PM Wrap-up discussion, what was learned, what are the challenges. Figure out driving to Denver tomorrow (who is taking who)

**Thursday, August 18, 2016- Biology and Next Generation Sequencing [B115]**

09:00-10:00 AM Biology 101 with Andy
10:00-11:00AM Sequencing Class and Core Facilities Tour with Jamie Prior Kershner
11:00-1:00 PM Drive to Anschutz and Lunch
1:00-4:00 PM Anschutz tour. April & Andy & Taisa (Drivers?)
(1-2pm) Katerina Kechriss, walking tour of Anschutz campus and hear about her research.
(2-2:30pm) Kathleen Barnes, Anschutz Center for Personalized Medicine.
(2:45-3:15pm) Bifeng Gao, Anschutz Genomics Core
Aaron Wacholder (IQ Biology ‘13, Pollock Lab)
4:00-5:00 PM Drive back to Boulder

**Friday, August 19, 2016 [B115]**

9:00 AM -12:00 PM Academic Advising Committee Meeting
12:00-12:45 PM Faculty Lunch! Chat with prospective rotation advisors.
12:45-3:30PM Research presentations - 10 min short talks from IQ affiliated labs
3:30 - 4:00PM Boot camp evaluations
5:00-6:30PM BioFrontiers BBQ (South Boulder Rec Center)

**Monday, August 22, 2016** Classes begin

*The Bootcamp will be organized, planned and carried out by 2nd year IQ Biology students.*

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**Core Courses**

New interdisciplinary courses* have been developed to provide IQ Biology and other graduate students with a deeper knowledge of mathematical and computational approaches to solving bioscience and bioengineering problems. These courses are taken within an interdisciplinary team environment. All IQ Biology students will take these core courses together in their first year; first year students will also enroll in the research rotation course.

**Fall Semester 2016:**

**Quantitative Optical Imaging** (4 credits)
Professor: Joel Kralj

*Meeting time/place: MWF 11:30 – 12:20 JSCBB (BIOT B331)  
Course Listing: MCDB 5312-800 (24162)  
Lab: Thursday afternoon 1:00-4:00 (no separate registration required for lab)  
Professor: Joseph Dragavon*

**IQ Biology Research Rotation** (3 credits)
Professor: Hubert Yin

*Course Listing: CHEM 6901-898 (2168)*

* Up-to-date course information can be found online at [http://IQBiology.colorado.edu](http://IQBiology.colorado.edu)
Spring Semester 2016: (more info coming soon)

**Mathematical and Computational Biology** (4 credits)
*Professor:* Manuel Lladser
*Meeting time/place:* TBD
*Course Listings:*

**Biophysics** (4 credits)
*Professor:* Meredith Betterton
*Meeting time/place:* TBD
*Course Listings:* TBD

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**Summer Courses**
It is the official policy of the IQ Biology program that we do not support summer coursework. Please plan your fall and spring coursework accordingly.

**Gap-Filling Courses**
You will also take up to two courses from already existing course offerings to balance your background with your desired research activities. These “gap-filling” courses give you an opportunity to broaden your capabilities and explore areas of quantitative biology that are new to you. Courses from any of our participating departments can be chosen, depending on your background and future research interests. The selection of these courses will be approved or assigned by the Academic Advising who will take into consideration the IQ Biology Core Competencies and Key Foundational Areas as well as your individual research interests. Undergraduate coursework may be taken for one of the two courses; however, the graduate school will not allow undergraduate credits to apply toward the credits required for a Ph.D. by the Graduate School.

To find courses you might like to take, please explore the course listings of our participating departments.

**Study Aids**
To help students prepare for the IQ Biology core courses, we have put together a list of study aids. Provided in Appendix E are a mixture of online resources and textbooks that are organized by subject area.

**Tutors**
The IQ Biology PhD Program also provides tutors who help provide additional support to students as needed. IQ Biology tutors are available in the areas of Biology, Computer Science
and Mathematics and are able to assist students gain knowledge important to the IQ Biology Core courses, gap-filling courses and their research. Please contact IQ Biology staff for more information.

ETHICS Course Requirements

All CU-Boulder research trainees or student employees supported by NSF grant funds can meet NSF requirements in one of three ways listed below. NIH trainees cannot use the online course (option 1 below) to meet the RCR requirement. They may only meet the requirement through options 2 or 3.

1. Complete the on-line course offered by the Collaborative Institutional Training Initiative (CITI). [http://www.colorado.edu/vcr/rcr/training/online-training](http://www.colorado.edu/vcr/rcr/training/online-training) is the most common way NSF trainees meet the RCR requirements.

2. Complete an interactive classroom-based course offered by various departments on the CU-Boulder or UC Denver Anschutz Medical campus. Students are required to take the course for credit and achieve a grade of B or higher. Postdocs may audit the course and request a letter of certification from the instructor. See [http://www.colorado.edu/vcr/rcr/training/classroom-training](http://www.colorado.edu/vcr/rcr/training/classroom-training).

3. Complete the RCR course offered in the fall semester each year that is specifically designed to meet the NSF and NIH RCR requirement. See below and/or contact the RCR Coordinator at rcr@colorado.edu for details and to enroll.

If completion of RCR training is accomplished through a departmental course (Option number 2 above), the trainee should complete the CU-Boulder RCR Completion Form, sign the original and submit it to the RCR Coordinator (campus mailbox: UCB 26). Also a copy should be given to the trainee’s mentor/PI for the NSF-funded award, a copy kept for his or her records.

Completion of RCR requirements through CITI (Number 1 option above) does not require the filing of a completion form as CITI will notify the RCR coordinator.

The classroom course mentioned in number 3 above has been established to satisfy these requirements and the purpose of this E-mail is to inform you about the course.

The non-credit course will take place this fall 2016 semester on Monday evenings starting on August 25 and ending on Nov 3rd. It will meet in Hellems 252 from 5:00 to 5:50 PM in a lecture format and then from 6:00 to 6:50 PM in small discussion groups in several other rooms in Hellems. The topics and lecturers are as follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 7</td>
<td>Orientation and Introduction</td>
<td>Dale Mood</td>
</tr>
<tr>
<td>Sept. 14</td>
<td>Mentor/Trainee Issues</td>
<td>Will Old</td>
</tr>
<tr>
<td>Sept. 21</td>
<td>Data Acquisition &amp; Management</td>
<td>Mike Stallings</td>
</tr>
<tr>
<td></td>
<td>Data Reproducibility</td>
<td>Joe Falke</td>
</tr>
<tr>
<td>Sept. 28</td>
<td>Lab Safety</td>
<td>Holly Gates-Meyer</td>
</tr>
<tr>
<td>Oct. 5</td>
<td>Auth. and Publ. Issues/Peer Review</td>
<td>Doug Seals</td>
</tr>
<tr>
<td>Oct. 12</td>
<td>Conflict of Interest</td>
<td>Pam Rosse</td>
</tr>
</tbody>
</table>
Oct. 19  Research Misconduct  Joe Rosse/Mary Allen  
Oct. 26  Protection of Human Subjects  Claire Dunn  
Protection of Animal Subjects  Chris Lowry  
Nov. 2  Collaborative Res/Intellectual Property  Brynmor Rees/Caroline Himes  
Nov. 9  The Scientist in Society  Roger Pielke  

Please have any trainees who would like to take this course this semester contact Dale Mood (mood@colorado.edu) to get enrolled.

*Ethics course must be completed in your second year. Please scan certificate of completion and email to education programs manager, Amber McDonnell, at amber.mcdonnell@colorado.edu*

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**Additional Requirements and Opportunities**

**Lab Rotations**

All first-year IQ Biology students will participate in three, 10-week research rotations. Each rotation must be in a different lab and in at least two different departments/disciplines; students are also expected to have both wet and dry lab experiences. Research rotations should fit with your research interests but challenge you to learn new techniques and introduce you to ideas outside of your primary discipline. First year students conducting research rotations will sign up for three credits of **CHEM 6901-898** per semester for a grade.

For each rotation period you will provide us with a ranked list of your “top three” lab preferences keeping in mind the spirit of interdisciplinary research. For example, if you have little or no wet lab experience, strive to rotate in labs that will offer this opportunity for you. We will make every effort to give students their first choice of labs for their rotation assignments; however, we also will be considering other student preferences and availability in each lab so you may not always get your first choice. To help you make an informed decision, please visit our website’s [faculty page](#) to check out their research and find contact information. In addition to the IQ Biology faculty, it is possible to rotate in the labs of any of the faculty from our [participating departments](#).

Rotation research is an opportunity to explore potential advisors, different departments, and new research techniques. You should meet with several faculty members so that you can get a feel for the various research and mentoring environments. Not sure what to say? Here is some advice on how to prepare for your rotation research projects (click for [tips](#) and recommended [resources](#) from the Hirschey Lab and [BMCDB Graduate Group at UC Davis](#)). Additional thoughts
to consider when choosing a thesis labs, also apply when considering a rotation lab. Visit the Washington University St. Louis website, to find more advice!

Once you have made your decision, there is still a lot you can do to get the most out of each opportunity; we require that you sit down and talk with your advisor at the very beginning of the rotation. This conversation is a chance for you to get to know each other and to talk more precisely about how your interests align. So prepare in advance to talk about the things you hope to get out of the laboratory experience and to learn as much as possible about the advisor’s expectations of rotation (and dissertation) students. For example, you may wish to:

- Let the PI know about your research, education and career goals
- Find out what the PI expects as far as
  - Hours per week spent in the lab
  - Events to attend
  - Lab responsibilities to assume
  - Etiquette to follow
  - Skills, technique sand abilities to demonstrate
- Discuss how the PI ultimately decides who to invite to join the lab, and how many dissertation research slots he/she has
- Review possible rotation projects and how they may become thesis projects

It is possible for you to develop rotation projects that span labs within a rotation session or between consecutive sessions. You may also work collaboratively with another student as long as there are specific outcomes expected for each student. You will not be limited to these labs when choosing your PhD advisor(s); any IQ Biology faculty member (or any faculty member with agreement of the Academic Advising) is eligible.

After each rotation, every student will present their results in a short talk during the Idea Exchange. **ONE week prior to the presentation students must email the title, authors and abstract for the talk.** These abstract will be made available on the IQ Biology web site. The guidelines are available in Appendix F. After these seminars, faculty who hosted rotations students will be asked to provide an assessment of their student’s performance.

Suggestions for your rotation talk:

- Your PowerPoint presentation should last 10 minutes. After your talk, there will be ~3-5 minutes for questions.
- About 1 slide per minute is a good general guideline to follow.
- Include background appropriate for a diverse audience. Explain clearly your interest in the project and why your audience could be too.
- Be sure to explicitly state the scientific question you were working on, even if your actual research addressed just a small aspect of that larger question.
- Explain your methods. Technical terms should either be avoided or clearly and succinctly explained.
• Demonstrate the progress you made toward answering your question of interest. Be sure to explain each of your figures (including labeling any axes) and provide your audience with the main point they should take away from each one.
• Suggest what one could do as an immediate follow-up to the work you did that would further address your larger question of interest.
• Engage your audience. It doesn’t hurt to make eye contact, smile, use some (appropriate) humor, ask the audience a question, etc.
• Be engaged. If you are in the audience, enjoy the opportunity to learn something new and be thinking about a question you could ask the speaker.

Seminars
First years must attend one “IQ Biology Seminar” per week—including BioFrontiers sponsored symposia and seminars. In subsequent years, IQ biology students are strongly encouraged to attend BioFrontiers sponsored Seminars and Symposia. Many of these will be seminars will be drawn from colloquia organized by the various departments, the BioFrontiers Institute, and IQ Biology students and faculty. When possible, students will meet with the speaker for an hour to discuss a relevant paper or another topic. Please check the IQ Biology Calendar for the dates, times, and locations of these seminars, as they will be different every week.

Data Science Supergroup
The data science Supergroup will be held periodically throughout the year in conjunction with the Signaling, Chemical Biology, and Biophysics Supergroups. First year IQ Biology students must present at one Supergroup meeting per year and more senior IQ Biology students are strongly encouraged to present. The 2016-2017 Supergroup schedule is as follows:
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 22</td>
<td>First day of classes</td>
</tr>
<tr>
<td>Aug 29</td>
<td>Biophysics</td>
</tr>
<tr>
<td>Sep 5</td>
<td>Labor Day HOLIDAY</td>
</tr>
<tr>
<td>Sep 12</td>
<td><strong>Signaling 1 slide summary, Social hour</strong></td>
</tr>
<tr>
<td>Sep 19</td>
<td>Biophysics <strong>Signaling 1 slide summary</strong></td>
</tr>
<tr>
<td>Sep 26</td>
<td><strong>Chemical Biology</strong></td>
</tr>
<tr>
<td>Oct 3</td>
<td>Biophysics</td>
</tr>
<tr>
<td>Oct 10</td>
<td><strong>Bioinformatics and Data Science</strong></td>
</tr>
<tr>
<td>Oct 17</td>
<td><strong>Signaling</strong></td>
</tr>
<tr>
<td>Oct 24</td>
<td><strong>Chemical Biology</strong></td>
</tr>
<tr>
<td>Oct 31</td>
<td>Halloween</td>
</tr>
<tr>
<td>Nov 7</td>
<td>Biophysics</td>
</tr>
<tr>
<td>Nov 14</td>
<td><strong>Signaling</strong></td>
</tr>
<tr>
<td>Nov 21</td>
<td>FALL BREAK HOLIDAY</td>
</tr>
<tr>
<td>Nov 28</td>
<td><strong>Bioinformatics and Data Science</strong></td>
</tr>
<tr>
<td>Dec 5</td>
<td>Biophysics</td>
</tr>
<tr>
<td>Dec 12</td>
<td>Finals Week</td>
</tr>
<tr>
<td>Jan 9</td>
<td>OPEN</td>
</tr>
<tr>
<td>Jan 16</td>
<td>MLK Day HOLIDAY</td>
</tr>
<tr>
<td>Jan 23</td>
<td><strong>Signaling</strong></td>
</tr>
<tr>
<td>Jan 30</td>
<td>Biophysics</td>
</tr>
<tr>
<td>Feb 6</td>
<td><strong>Bioinformatics and Data Science</strong></td>
</tr>
<tr>
<td>Feb 13</td>
<td><strong>Chemical Biology</strong></td>
</tr>
<tr>
<td>Feb 20</td>
<td>Biophysics</td>
</tr>
<tr>
<td>Feb 27</td>
<td><strong>Signaling</strong></td>
</tr>
<tr>
<td>Mar 6</td>
<td><strong>Bioinformatics and Data Science</strong></td>
</tr>
<tr>
<td>Mar 13</td>
<td>OPEN</td>
</tr>
<tr>
<td>Mar 20</td>
<td>Biophysics</td>
</tr>
<tr>
<td>Mar 27</td>
<td>SPRING BREAK HOLIDAY</td>
</tr>
<tr>
<td>Apr 3</td>
<td><strong>Bioinformatics and Data Science</strong></td>
</tr>
<tr>
<td>Apr 10</td>
<td><strong>Signaling</strong></td>
</tr>
<tr>
<td>Apr 17</td>
<td><strong>Chemical Biology</strong></td>
</tr>
<tr>
<td>Apr 24</td>
<td>Biophysics</td>
</tr>
<tr>
<td>May 1</td>
<td><strong>Bioinformatics and Data Science (optional)</strong></td>
</tr>
<tr>
<td>May 8</td>
<td>(Finals Week)</td>
</tr>
<tr>
<td>May 15</td>
<td><strong>SCR Symposium – Tim Mitchison and Klaus Hahn</strong></td>
</tr>
</tbody>
</table>

**Idea Exchange**

Idea Exchanges are an opportunity for students and faculty to work on team projects, talk about research topics and ideas, hold workshops, and learn about new discoveries in quantitative biology. The agenda and format will vary from week to week. All first year IQ Biology students are asked to attend sessions held once per week in room B224 of the Jennie Smoly Caruthers Biotechnology Building (JSCBB). The dates and times will be determined based on your schedule each semester. See the [IQ Biology Calendar](#) for the schedule of what is occurring each week.

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Student Symposium
Third-year students will organize an IQ Biology symposium every other year to present the research advances of IQ Biology participants. The research should be presented in a jargon-free format accessible to scholars from multiple disciplines, as well as the public. Research will be evaluated and awards given out by participating faculty members and members of the IQ Biology Advisory Board. Since professionals and researchers in government labs and industry will attend the symposium, it will also function as a networking event for those students interested in internships and careers outside academia.

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Teaching
IQ Biology does not have any teaching requirements. However, each degree program does have specific requirements that will apply to you after you choose your degree program in May of your first year (see the MOUs). There are opportunities for students to teach in the IQ Biology core courses if you are interested.

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Dissertation Research
You will fulfill the PhD requirements of your chosen degree program, but some elective coursework requirements of the departments will be substituted with courses from the IQ Biology program. Upon graduation, you will receive a PhD from your degree-granting department and an interdisciplinary certificate from the Graduate School in IQ Biology. See the MOUs with each participating degree program for more details.

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Exams
There are no IQ Biology-specific exams outside of the core courses. There will be exams required by your chosen degree program, but they may be modified to accommodate your participation in IQ Biology. For details, see the MOUs with each participating degree program.

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Internships

IQ Biology was designed to be a hub of activity, connecting you to the people and resources you need to create your future. In addition to excellent teaching faculty and a structure that crosses academic silos, IQ Biology also focuses on helping you develop professionally. A list of companies and organizations who are excited to receive internship applications from IQ Biology students is available on our website. Please email IQBiology@colorado.edu if you are interested in pursuing an internship at one of these or any other organization.

Community Engagement

All IQ Biology students are required to participate in at least one outreach activity before graduation. This activity must be approved by the IQ Biology Academic Advising Committee before you begin. There are many wonderful avenues for outreach at CU-Boulder, below is a small sampling of possible activities, but other activities you find may be appropriate as well.

- Integrating STEM Education (iSTEM)
- Physics Education Technology (PhET)
- Integrated Teaching and Learning Laboratory (ITLL)
- A list of many other outreach opportunities available at CU http://outreach.colorado.edu/
- International Genetically Engineered Machines (iGEM)

Other Opportunities

Student Leadership Council

The student leadership committee (SLC) is charged with developing and implementing activities and communicating ways that the IQ Biology program can best help students in their doctoral studies, career development, and community building. To facilitate the direct communication of student activities and needs to the faculty, at least one student from the student leadership committee will attend each IQ Biology steering committee meeting.

The SLC will also play a critical role in preparing our students to view the knowledge and skills gained through IQ Biology to their professional aspirations and societal impact. The goal is for students to apply this knowledge to careers as teachers, communicators, researchers, mentors, innovators, and entrepreneurs.

CU Café

CU Café is a collective of diverse STEM trainees that promotes inclusivity and scientific excellence and connects individuals who have a strong commitment to STEM scholarship, racial
and ethnic diversity, community building, and mentorship. CU Café values camaraderie, innovation, self-awareness, and self-empowerment, and we aspire to grow as scientists, professionals, and role models. CU Café has three primary aims:

- To challenge the status quo of diversity in STEM fields, with the goal of fostering understanding, respect, and community here at CU-Boulder.
- To empower our members to be agents of change and innovative leaders capable of fostering diversity and equity within STEM fields at CU-Boulder and the broader community.
- To advance the careers of our members by increasing their visibility, expanding their professional networks, and cultivating a diverse and inspiring environment that supports them throughout their academic journey.

CU Biotech Club
The [CU Biotech Club](#) is a campus-wide club of business, law, science and engineering students and post-docs. If you are interested in a career in biotech or finding out more about the innovation process from research to application, check out their website. You might consider joining the club or attending some of their events.

Biotechnology Opportunities Seminar Series
In collaboration with the [CU Biotech Club](#), BioFrontiers coordinates the Biotechnology Opportunities Seminar Series (BOSS) each year, which is generously sponsored by Jim & Patience Linfield and Cooley LLP. The students and post-docs who develop the BOSS events are paired with high-level industry mentors—relationships that they have often leveraged into internships, continued mentoring and job interviews. The seminars themselves are open to the entire CU community and provide an opportunity to meet industry professionals and learn more about the innovation process.

Colorado Advantage Preview Weekend for Underrepresented Minority Students
The [Colorado Advantage](#) is an opportunity for underrepresented minority seniors interested in graduate education to preview STEM doctoral programs at CU-Boulder during a fall weekend. The program is administered by the [Colorado Diversity Initiative](#), with financial support from its NSF AGEP grant, the Graduate School, BioFrontiers, the College of Engineering and Applied Sciences, the Office of the President, and enthusiastic commitments from faculty and students across all STEM departments. Current students can help potential applicants explore the campus, tour research labs, and prepare for graduate school. If you would like to participate in the program please contact [Barbara Kraus](#) at the Colorado Diversity Initiative.

BioFrontiers Science Alliance
The BioFrontiers Science Alliance (BFSA) is an organization comprised of students and postdoctoral researchers engaged in fundamental and applied science. The mission of the BFSA is to promote camaraderie and exchange of knowledge between students across the
BioFrontiers Institute and the entire University of Colorado. They seek to develop a community that extends beyond the doors of the laboratory by assisting our members to become more effective at communicating their research to an interdisciplinary audience and to broaden their foundational scientific fluency across departmental divisions.

The group’s vision brings together burgeoning scientists and engineers with a range of expertise and skills to talk about ongoing research and emerging scientific questions. They promote interdisciplinary collaborations, encourage novel research approaches, and facilitate knowledge sharing. With members spanning biological, physical and computer sciences, as well as engineering, they strive to create a community of scholars within the BioFrontiers Institute and beyond.

**Departmental Retreats**

Several departments also hold departmental retreats that feature informal research talks and discussions and are usually held at a location off campus. Faculty, students and fellows attend these functions that provide outstanding opportunities to find out about the diverse research underway in the department and select rotation advisors. The IQ Biology program will cover the cost of up to two retreats (support per event is capped at $250) for each first year student.

Not every department holds an annual retreat. We are aware that Ecology and Evolutionary Biology; Biochemistry; Molecular, Cellular, and Developmental Biology; and the Computational Science Program (on the Anschutz Medical Campus) regularly hold retreats. You may contact IQ Biology or the graduate advisor in each department for retreat dates and other information.

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**Student Compensation**

During the first two years of graduate school, IQ Biology students are paid an annual stipend of $30,000. Additionally, the IQ Biology program will fully cover the student's tuition, fees, and health insurance. After the first two years, students will be compensated at a rate determined by their academic department. One of the benefits of the student fees is access to the Student Recreation Center—students only need to show your BuffOne card at the recreation center and you will be admitted.

Also, please note that during the summer, graduate research assistants (NOTE: this does not apply to those designated as “fellows”) are automatically enrolled in the student retirement plan (participation is mandatory) and an additional percentage will be deducted from the stipend. Information can be found here and on page 9 of the Graduate Student Appointment Manual. If you wish to make voluntary contributions to a retirement plan, enrollment forms can
be found on the CU Boulder website (http://www.cu.edu/employee-services/benefits/student-employee-retirement). The summer mandatory retirement contribution is separate from any voluntary contributions that you may make. Don’t worry, the university isn’t really taking this money from you… it is YOURS! You can take it with you when you graduate and continue to watch it grow until you decide you’re ready to retire!

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Travel Funds

The IQ Biology program allows each student to apply for up to $1000 in travel funds to attend an interdisciplinary meeting. Students may apply at any time, but are eligible to receive these funds only once.

These funds are intended to facilitate opportunities to pursue interdisciplinary experiences at conferences, workshops, and research collaborations. You can find the application and further information online at https://iqbiology.colorado.edu/current-students/resources/travel-awards.

Guidelines for IQ Biology Conference/Travel Funds Application

Award Description:

1) Funds can be distributed in any year, but students may receive funds only once during their graduate studies.
2) Funds can be used to cover the cost of travel, food, materials, or registration fees.
3) Travel expenses, food, and non-alcoholic beverages will be reimbursed up to $1000.
4) Receipts must be submitted along with a form for reimbursement
5) Upon return a 250-500 word blog-post must be written for publication on the BioFrontiers Website. Once the blog is received, the student will be reimbursed for the travel.

Eligibility:

1) Only current IQ Biology students may apply.
2) The student MUST be one of the following:
   a. Attending a conference outside their primary discipline;
   b. Presenting research done outside of the primary discipline of the conference;
   c. Attending an interdisciplinary conference; or
   d. Visiting another PI’s lab with the goal of interdisciplinary study.
3) A presentation† must be made (poster or talk accepted at conference, talk to lab/department at visiting institution).

† In some instances, the presentation requirement may be waved. Please see the application or contact IQ Biology staff for details.
4) The application must be submitted to IQBiology@colorado.edu at least one month prior to date of travel. Additionally, applicants must allow one month for the applications to be reviewed and for funding decisions to be made. Not all applications will necessarily be accepted.

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Independent Funding Opportunities

We encourage all students to seek independent funding opportunities. Having your own funding will provide you with greater flexibility and independence as you pursue your PhD. The federal government offers a significant number of grants through agencies like the National Science Foundation (NSF), the National Institutes of Health (NIH) and the Department of Defense (DoD). In addition, independent funding for graduate school is also offered by private foundations, public charities, and corporate foundations.

Aid to individuals is usually given in the form of either direct support or fellowships for travel and research in a host country/institution/library. The Foundation Center www.fdncenter.org has an extensive list of resources. Additionally, their annual publication Foundation Grants to Individuals is an excellent resource. The CU Boulder Graduate School lists several funding opportunities specific to doctoral students. Specific funding opportunities include:

- Graduate Research Fellowships (NSF)
- Ruth L. Kirschstein NRSA Individual Fellowships (NIH)
- National Defense Science and Engineering Graduate (NDSEG) Fellowships (DoD)
- Ford Foundation Fellowships administered by the National Research Council

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Staying Connected with IQ Biology

As already mentioned, IQ Biology students have the duration of their first year at CU Boulder to develop their research ideas in an interdisciplinary community, free from departmental requirements. Meeting faculty through idea exchanges, research rotations, classroom activities, and department events are important ways to get to know about the research projects and cultures of various departments and laboratories. Thus, we encourage students to do as much exploration as possible of the various opportunities the university has to offer.

The benefits of participating in IQ Biology do not end with the first year! In year two (2) and beyond students should attend an Idea Exchange of their choice monthly, participate in
Outreach Activities, Symposium, invite and interface with leading scientist from across the country, internship opportunities, mentorship to new students, and the BioFrontiers Symposium.

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Calendars and Links

Please check the IQ Biology Calendar for courses, seminars and activities required for IQ Biology students.

Please check the Seminar Calendar for seminars and events from CU, BioFrontiers and our participating departments that might be of interest to you.

Please check the IQ Biology channel on SLACK, the primary news and updates communication platform for the IQ Biology program. You will receive an invitation to join the IQ Biology SLACK channel through your student email account.

The Student Google Drive is home to important forms, information and the current Graduate Handbook. You will receive an invitation to join through your student email account, and will be prompted to sign in using your IdentiKey and password.

Follow BioFrontiers on Twitter! Go to: http://twitter.com/biofrontiers

We have an IQ Biology Facebook page that will have weekly posts about news and the labs affiliated with our program. Please “like” us and use the page to post your own questions and comments.

Make sure you have a CU-Boulder email account (using this link). All relevant information will be sent to this account.

Visit the IQ Biology website for regular updates.

Check out CU-Boulder’s Graduate School website for additional information on life as a graduate student at CU-Boulder.

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Academic Advising and Thesis Committees

You will meet with the IQ Biology Academic Advising Committee three times in your first year: just before classes start in August, in November/December, and in March/April. Newly admitted students are also assigned summer mentoring contacts (both student and faculty mentors) that are available to answer questions before you arrive. The Academic Advising Committee also reviews and approves travel award applications and outreach activities.

At the August academic advising meeting each student’s plan of study will be developed. This plan will include possible gap-filling courses, research rotations (for first-year students), and interdisciplinary collaborations (for current students). During the November/December meeting students will discuss their fall semester progress, the next research rotations, and the spring gap-filling course. In the spring semester meeting, the student discusses options for choosing a Ph.D. degree program and advisor with the committee.

The Academic Advising Committee will be following some guiding principles when helping you shape your graduate studies. They are:

- Gap-filling courses are to help students broaden their capabilities and should not be used to fulfill degree coursework;
- Research rotations should fit with the students’ research interests but challenge them to learn new techniques and be introduced to ideas outside of their primary discipline;
- At some point, every student will interact with living material (e.g., organisms, cells, or tissues);
- Consider the IQ Biology Core Competencies and the students’ skills to suggest/assign activities that address areas where students need to gain proficiency; and
- Consider the IQ Biology Key Foundational Areas and the students’ backgrounds to assign courses, suggest rotations, and suggest advisors/labs that will allow them to address two of the bioscience areas and two of the quantitative areas.

Ph.D. Dissertation Committee

Your Ph.D. dissertation committee will be formed as required by the rules of your chosen degree program, with two modifications: at least one member of your committee must be an out-of-discipline IQ Biology faculty member and you must meet with your committee at least once a year. Please inform us at IQBiology@Colorado.edu of whom you have chosen to be your IQ Biology representative.
Participating Degree Programs

There are currently eight participating degree programs associated with the IQ Biology Certificate Program.

The participating degree programs are:
- Applied Mathematics
- Chemistry and Biochemistry
- Chemical & Biological Engineering
- Computer Science
- Ecology & Evolutionary Biology
- Geology
- Material Science & Engineering
- Mechanical Engineering
- Molecular, Cellular, & Developmental Biology
- Physics

In May of your first year, you may choose between any of the degree programs for which you were pre-approved, or another degree program by arrangement. If you would like to pursue your Ph.D. in a degree program other than one you were pre-approved for during your application process, please speak with the academic advising committee and Andrea Stith; they will be able to help you apply.

For students joining IQ Biology in their first year, memorandums of understanding (MOUs) have been written that outline how students will complete the requirements for both the certificate program and the degree program. Summaries of those agreements are shown here; the official MOUs are provided in the Appendix. These MOUs do not apply to students who have joined the certificate program after their first year.

The main aims of the MOUs are to maintain flexibility for coursework and research within the student’s first year; to minimize time to degree (specifically to not delay the student by more than a semester due to the assigned coursework); and to integrate students into their departmental cohort while keeping them pro-active members of IQ Biology. To achieve these goals, IQ Biology program and participating degree programs have agreed that IQ Biology courses count as pre-approved electives; students are relieved of their teaching duties in their first year; some early course-based departmental exams are delayed until the second year; the research-based departmental exams are delayed only slightly; and students are advised such that they remain on track with both department and IQ Biology students.
Transitioning to the Degree Program

IQ Biology works in partnership with each participating department to make this transition as smooth as possible. IQ Biology students should inform Andrea Stith as soon as they have chosen their degree program and dissertation advisor. Official forms require the signature of the student, PI, a departmental representative, and an IQ Biology committee members are provides. Students are responsible for communicating with his or her advisor and the department’s graduate program chair and graduate advisor. Please be aware that upon deciding on a degree program, students should immediately register for their fall courses of choice, as some tend to fill up quickly. Please inform IQ Biology of your decision by returning assigned 2nd year transition form to program staff.
# Applied Mathematics

## IQ Biology Certificate Program Outline

### General Notes:
- Apply to certificate program & to 3 possible home depts.
- Flexible curriculum in 1st year defined by student & IQ Biology Advising Committee.
- Three 10 wk rotations over 9 mo in at least 2 depts, modeled after MCDB/Biochem.
- Students have a space to sit together in the JSC Biotech Bldg during their 1st year.

<table>
<thead>
<tr>
<th>1st Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>funded by IQ Biology</td>
<td>IQ Bio Core (6 credits)</td>
<td>IQ Bio Core (6 credits)</td>
<td>IQ Biology Core &amp; electives</td>
<td>count as out-of-dept credits.</td>
</tr>
<tr>
<td></td>
<td>BIOF/IQ Bio Seminar (1)</td>
<td>BIOF/IQ Bio Seminar (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IQ Biology elective (3)</td>
<td>IQ Biology elective (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>research rotation (TBD)</td>
<td>research rotation (TBD)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Choose dept. & advisor by end of spring semest. OK

### Summer between 1st and 2nd year: Conduct research in chosen lab

<table>
<thead>
<tr>
<th>2nd Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
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<td>BIOF/IQ Bio Seminar (0)</td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>Applied Analysis (3)</td>
<td>Applied Analysis (3)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Comp. Math (3)</td>
<td>Comp. Math (3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>research (TBD)</td>
<td>research (TBD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 sem. Language requirement, can test out of</td>
<td></td>
</tr>
</tbody>
</table>

### Summer between 2nd & 3rd year: Assigned to mentor a 1st year IQ Biology student

Present at IQ Biology Student Symposium

<table>
<thead>
<tr>
<th>3rd Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>Prob.&amp;Stats. (3)</td>
<td>Prob.&amp;Stats. (3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>research (TBD)</td>
<td>research (TBD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TA</td>
<td>TA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>oral exam by end of third year.</td>
</tr>
</tbody>
</table>

### Summer b/w 3rd&4th year: Organize student symposium

<table>
<thead>
<tr>
<th>4th Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>research (TBD)</td>
<td>research (TBD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TA</td>
<td>TA</td>
</tr>
</tbody>
</table>

## Notes on Differences from the Traditional Applied Mathematics PhD Program:

The first year IQ Biology core and elective courses count towards the required out-of-dept credits.

IQ Biology students will take the following preliminary exams and associated coursework as necessary: Numerical Analysis, Applied Analysis, and Probability & Statistics.

Postpone the deadline of the comprehensive oral thesis proposal to the end of the third year.

Have an IQ Biology faculty member on the student’s thesis committee.

Note: the preliminary exams can be taken in an alternative order than presented here.

All courses must be passed with a B- or above.

Last Updated: 16-Aug-12
# Chemistry and Biochemistry

## IQ Biology Certificate Program Outline

<table>
<thead>
<tr>
<th>1st Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IQ Bio Core (6 credits)</td>
<td>IQ Bio Core (3+3 credits)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funded by</td>
<td>BIOF/IQ Bio Seminar (1)</td>
<td>BIOF/IQ Bio Seminar (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IQ Bio</td>
<td>IQ Biology elective (3)</td>
<td>IQ Biology elective (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>research rotation (TBD)</td>
<td>research rotation (TBD)</td>
<td></td>
<td></td>
</tr>
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</table>

Choose dept. & advisor by end of spring semest. Ok, alongside prelims.

## BIOCHEMISTRY PhD DEGREE PROGRAM

<table>
<thead>
<tr>
<th>2nd Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer between 1st and 2nd year: Conduct research in chosen lab</td>
<td>Biochem Core (5)</td>
<td>Dept. Seminar (0)</td>
<td>Biochem Core (5)</td>
<td>Dept. Seminar (0)</td>
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<tr>
<td>Biochem Core (5)</td>
<td>Dept. Seminar (0)</td>
<td>Biochem Core (5)</td>
<td>Dept. Seminar (0)</td>
<td></td>
</tr>
<tr>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td></td>
</tr>
<tr>
<td>ethics course (1)</td>
<td>Comps in June</td>
<td>possible elective (TBD)</td>
<td>Orals in July</td>
<td></td>
</tr>
<tr>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td></td>
</tr>
</tbody>
</table>

## 3rd Year

<table>
<thead>
<tr>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
</tr>
<tr>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
</tr>
<tr>
<td>research (TBD)</td>
<td>research (TBD)</td>
<td>research (TBD)</td>
<td>research (TBD)</td>
</tr>
</tbody>
</table>

## 4th Year

<table>
<thead>
<tr>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>BIOF/IQ Bio Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
</tr>
<tr>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
<td>Dept. Seminar (0)</td>
</tr>
<tr>
<td>research (TBD)</td>
<td>research (TBD)</td>
<td>research (TBD)</td>
<td>research (TBD)</td>
</tr>
</tbody>
</table>

## Notes on Differences From the Traditional Biochemistry PhD Program:

Reasonable graduate coursework taken in year 1 would be approved by the biochem graduate advisor (committee chair). Selection of advisor would occur alongside the prelim evaluation of Biochem students at the May faculty meeting.

Comps deadline postponed to end of 2nd year, and Orals to July after student’s 2nd year.

The orals committee will consist of at least one faculty member outside of the department, at advisor’s discretion.

If student needs to take the Comps again in Dec. of 3rd year, they would then take Orals by March of 3rd year.

Last Updated: 16-Aug-12

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IQ-Bio Certificate Program Outline

Apply to program & to 3 possible home depts.
Flexible curriculum in 1st year defined by student & IQ-Bio Advising Committee.
Three 10 wk rotations over 9 mo in at least 2 depts, modeled after MCDB/Biochem.
Students will have a space to sit together in the Systems Biotech Bldg during their 1st year.

<table>
<thead>
<tr>
<th>1st Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year:</td>
<td>IQ-Bio Core (6 credits)</td>
<td>IQ-Bio Core (6 credits)</td>
<td>substitute this for the 1st year Dept Seminar</td>
<td>substitute this for the 1st year Dept Seminar</td>
</tr>
<tr>
<td>IQ-Bio</td>
<td>BIOF/IQ-Bio Seminar (1)</td>
<td>BIOF/IQ-Bio Seminar (1)</td>
<td>Some IQ-Bio elective credit would</td>
<td>Some IQ-Bio elective credit would</td>
</tr>
<tr>
<td>funded by</td>
<td>fill b/g gap course (3)</td>
<td>fill b/g gap course (3)</td>
<td>count toward CBEN elective credit.</td>
<td>count toward CBEN elective credit.</td>
</tr>
<tr>
<td>IQ-Bio</td>
<td>research rotation (#?)</td>
<td>research rotation (#?)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Choose dept. & advisor by end of spring semest. ok

Summer between 1st and 2nd year: Conduct research in chosen lab
BIOF/IQ-Bio Seminar (0) BIOF/IQ-Bio Seminar (0)

Summer between 2nd & 3rd year: Assigned to mentor a 1st year IQ-Bio student
Present at IQ-Bio Student Symposium

CHEN Core (3) CHEN Core (4)
waive additional dept course req.

Postpone the deadline of the qualifying exam till the end of the 2nd semester in the 2nd year.

Postpone project selection for the 1-2 IQ-Bio students till May of their first year.

Notes on Differences From the Traditional CHEN PhD Program:
Count the IQ-Bio seminar as credit toward the departmental seminar in the first year.
Count some of the IQ-Bio core courses toward the Departmental elective courses (could cross list).
The CHEN Core Courses are: CHEN 5210, 5370, 5390 and 5740. (These are the same.)
Postpone project selection for the 1-2 IQ-Bio students till May of their first year.

Extension of graduation date to 5.5 years, or count 2nd year as year 1 in the dept in this respect.
All students entering the program without a degree closely-related to chemical engineering must either take the Fundamentals of Engineering exam or have completed four chemical engineering core undergraduate courses with a grade of B or better (Fluids/Heat, Mass Transfer, Thermodynamics, Kinetics or the equivalent courses).

Last Updated:16-Aug-12

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## Computer Science

### IQ Biology Certificate Program Outline

**General Notes:**
- Apply to certificate program & to 3 possible home depts.
- Flexible curriculum in 1st year defined by student & IQ Biology Advising Committee.
- Three 10 wk rotations over 9 mo in at least 2 depts, modeled after MCDB/Biochem.
- Students will have a space to sit together in the JSC Biotech Bldg during their 1st year.

<table>
<thead>
<tr>
<th>Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>IQ Biology Core (6 credits)</td>
<td>IQ Biology Core (3+3 credits)</td>
<td>Cross-list 2nd sem. Genomics course (3) in CS</td>
<td>Count 6 credits of core to out-of-dept electives</td>
</tr>
<tr>
<td></td>
<td>IQ Biology elective (3)</td>
<td>IQ Biology elective (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>research rotation (TBD)</td>
<td>research rotation (TBD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Choose dept. &amp; advisor by end of spring sem.</td>
<td>ok</td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd</td>
<td>BIOF/IQ Biology Seminar (1)</td>
<td>BIOF/IQ Biology Seminar (1)</td>
<td>Courses taken in 2nd and 3rd year:</td>
<td>bioinformatics prelim*</td>
</tr>
<tr>
<td></td>
<td>IQ Biology elective (3)</td>
<td>IQ Biology elective (3)</td>
<td>5 CS distribution courses</td>
<td>research (TBD)</td>
</tr>
<tr>
<td></td>
<td>research rotation (TBD)</td>
<td>research rotation (TBD)</td>
<td>2 other CS courses</td>
<td>research (TBD)</td>
</tr>
</tbody>
</table>

**Notes on Differences From the Traditional CS PhD Program:**
- Cross-list the 2nd semester IQ Biology Core Course "Stats&Computation for Genome/Metagenomes" in CS (3 cred; Developed by Rob Knight, Robin Dowell and Manuel Lladser).
- Count the 1st semester IQ Bio Core Course credits as approved out-of-dept. elective credit (6 cred; Developed by Meredith Betterton et al. "Foundations in Quant. Bio.").
- 21 credit hours of CS courses (or courses cross-listed in CS) at the 5000+ level
- At least one member of the student's committee must be an IQ Biology faculty member.
- Deadline for prelim postponed till end of 3rd year.
- Deadline for thesis proposal/oral exam postponed till end of 4th year.
- A scientific ethics course/workshop must be taken before graduation.

Last Updated: 16-Aug-12

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# Ecology & Evolutionary Biology

<table>
<thead>
<tr>
<th>IQ-Bio Certificate Program Outline</th>
<th>Ecology and Evolutionary Bio PhD Program</th>
</tr>
</thead>
</table>

## General Notes:
- Apply to certificate program & to 3 possible home depts.
- Flexible curriculum in 1st year defined by student & IQ Biology Advising Committee.
- Three 10 wk rotations over 9 mo in at least 2 depts, modeled after MCDB/Biochem.
- Students will have a space to sit together in the JSC Biotech Bldg during their 1st year.

## 1st Year:

**1st Semester**
- IQ Biology Core (6 credits)
- BIOF/IQ Bio Seminar (1)
- IQ Biology elective (3)
- research rotation (TBD)

**2nd Semester**
- IQ Biology Core (3+3 credits)
- BIOF/IQ Bio Seminar (1)
- IQ Biology elective (3)
- research rotation (TBD)

Choose dept. & advisor by end of spring semest. ok

## 2nd Year:

**1st Semester**
- BIOF/IQ Bio Seminar (0)

**2nd Semester**
- BIOF/IQ Bio Seminar (0)

**1st Semester**
- Form committee by Sept.  ~2-4 courses determined by the student’s committee based on student’s background
- Intro to Research EBIO 6000 (1)
- Seminar EBIO 5000 (1)

**2nd Semester**
- Seminar EBIO 5000 (1)
- research (TBD)

## 3rd Year:

**1st Semester**
- BIOF/IQ Bio Seminar (0)

**2nd Semester**
- BIOF/IQ Bio Seminar (0)

**1st Semester**
- Comps taken ("5th Semester Exam")
- TA b/w years 2-4 assigned (or not) by committee
- Seminar EBIO 5000 (1)

**2nd Semester**
- Seminar EBIO 5000 (1)
- research (TBD)

## 4th Year:

**1st Semester**
- BIOF/IQ Bio Seminar (0)

**2nd Semester**
- BIOF/IQ Bio Seminar (0)

**1st Semester**
- research (TBD)

**2nd Semester**
- research (TBD)

### Notes on Differences From the Traditional E-BIO PhD Program:
- Postpone the deadline for forming a committee and convening a first meeting till September of the student’s 2nd year.
- The Qualifying Exam (i.e. the "Third Semester Exam") is postponed till the beginning of the student’s 4th semester.
- IQ Biology students would not be required to TA in their first or second year.
- At least one member of the student’s committee must be an IQ Biology faculty member.
- A scientific ethics course or workshop must be taken before graduation.
Material Science and Engineering

IQ-Bio Certificate Program Outline

Chem. & Bio. Engineering Department

Apply to program & to 3 possible home depts.
Flexible curriculum in 1st year defined by student & IQ-Bio Advising Committee.
Three 10 week rotations over 9 months in at least 2 departments, modeled after MCDB
Students will have a space to sit together in the Systems Biotech Building during their 1st year.

<table>
<thead>
<tr>
<th>1st Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funded by</td>
<td>BIOF/IQ-Bio Seminar (1)</td>
<td>BIOF/IQ-Bio Seminar (1)</td>
<td>substitute this for the 1st year Dept Seminar</td>
<td></td>
</tr>
<tr>
<td>IQ-Bio</td>
<td>fill b/g gap course (3)</td>
<td>fill b/g gap course (3)</td>
<td>Some IQ-Bio elective credit would count toward CBEN elective credit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>research rotation (#?)</td>
<td>research rotation (#?)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Choose dept. & advisor by end of spring semester.

<table>
<thead>
<tr>
<th>2nd Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funded by</td>
<td>BIOF/IQ-Bio Seminar (0)</td>
<td>BIOF/IQ-Bio Seminar (0)</td>
</tr>
<tr>
<td>IQ-Bio</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summer between 1st and 2nd year: Conduct research in chosen lab

<table>
<thead>
<tr>
<th>3rd Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funded by</td>
<td>BIOF/IQ-Bio Seminar (0)</td>
<td>BIOF/IQ-Bio Seminar (0)</td>
</tr>
<tr>
<td>IQ-Bio</td>
<td></td>
<td></td>
</tr>
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</table>

Summer between 2nd & 3rd year: Assigned to mentor a 1st year IQ-Bio student
Present at IQ-Bio Student Symposium

<table>
<thead>
<tr>
<th>4th Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funded by</td>
<td>BIOF/IQ-Bio Seminar (0)</td>
<td>BIOF/IQ-Bio Seminar (0)</td>
</tr>
<tr>
<td>IQ-Bio</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summer b/w 3rd&4th year: Organize student symposium

Notes on Differences From the Traditional CHEN PhD Program:
Count the IQ-Bio seminar as credit toward the departmental seminar in the first year.
Count some of the IQ-Bio core courses toward the Departmental elective courses (could cross list).
Postpone project selection for the 1-2 IQ-Bio students till May of their first year.
Postpone the deadline of the qualifying exam till the end of the 2nd semester in the 2nd year.
Extension of graduation date to 5.5 years, or count 2nd year as year 1 in the dept in this respect.

All above pending MOU

Last Updated: 11-Aug-14
## IQ Biology Certificate Program Outline

### General Notes:
- Apply to certificate program & to 3 possible home depts.
- Flexible curriculum in 1st year defined by student & IQ Biology Advising Committee.
- Three 10 wk rotations over 9 mo in at least 2 depts, modeled after MCDB/Biochem.
- Students will have a space to sit together in the JSC Biotech Bldg during their 1st year.

<table>
<thead>
<tr>
<th>1st Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IQ Biology Core (6 credits)</strong></td>
<td><strong>IQ Biology Core (6 credits)</strong></td>
<td>waive Intro to Research Course</td>
<td>(good research practices will be covered in IQ Bio Core Course)</td>
<td></td>
</tr>
<tr>
<td><strong>Funded by IQ Biology</strong></td>
<td><strong>IQ Biology Elective (3)</strong></td>
<td><strong>IQ Biology Elective (3)</strong></td>
<td><strong>IQ Biology Elective (3)</strong></td>
<td><strong>IQ Biology Elective (3)</strong></td>
</tr>
<tr>
<td>BIOF/IQ Bio Seminar (1)</td>
<td>research rotation (TBD)</td>
<td>BIOF/IQ Bio Seminar (1)</td>
<td>research rotation (TBD)</td>
<td>BIOF/IQ Bio Seminar (1)</td>
</tr>
</tbody>
</table>

**IQ Bio courses will count towards ME Department enrichment credits (15 total needed for PhD)**

Choose dept. & advisor by end of spring semest.

### Total Credit Hours for Grade: 18

**Summer between 1st and 2nd year: Conduct research in chosen lab**

<table>
<thead>
<tr>
<th>2nd Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer between 2nd &amp; 3rd year: Assigned to mentor a 1st year IQ Biology student</strong></td>
<td><strong>Comps after 1st pub. (during 3rd or 4th year)</strong></td>
<td><strong>Grad Seminar 5027 (1)</strong></td>
<td><strong>Grad Seminar 5027 (1)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>BIOF/IQ Bio Seminar (0)</strong></td>
<td><strong>BIOF/IQ Bio Seminar (0)</strong></td>
<td><strong>ME Elective Course (3)</strong></td>
<td>research (TBD)</td>
<td></td>
</tr>
<tr>
<td><strong>ME Elective Course (3)</strong></td>
<td>research (TBD)</td>
<td><strong>Research (TBD)</strong></td>
<td>research (TBD)</td>
<td></td>
</tr>
<tr>
<td><strong>Research credit (3)</strong></td>
<td><strong>ME Core Course (3)</strong></td>
<td><strong>Grad Seminar 5027 (3)</strong></td>
<td><strong>Grad Seminar 5027 (1)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>MCEN 5040 - math (3)</strong></td>
<td>research (TBD)</td>
<td><strong>Research (TBD)</strong></td>
<td>research (TBD)</td>
<td></td>
</tr>
</tbody>
</table>

### Total Credit Hours for Grade: 18

**Summer b/w 3rd&4th year: Organize student symposium**

<table>
<thead>
<tr>
<th>4th Year</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIOF/IQ Bio Seminar (0)</strong></td>
<td><strong>BIOF/IQ Bio Seminar (0)</strong></td>
<td>research (TBD)</td>
<td>research (TBD)</td>
<td></td>
</tr>
</tbody>
</table>

### Total Credit Hours for Grade: 0

### Notes on Differences From the Traditional ME PhD Program:
- Waive two semesters of the ME graduate seminar requirement, substitute the IQ Biology seminar in 1st year
- Waive Intro to Research course, substitute the research rotation credits and the IQ Biology Core Course
- Count 12 credits from IQ Biology Core courses and 3 credits from IQ Biology electives (gap-filling) toward the ME enrichment course requirements
- Postpone prelim deadline to April in 2nd year
- A scientific ethics course (CHEN 5838, Chem 5776, MCDB 5776) or workshop is required. The course is 1 credit and the workshop is 0 credits
- At least one member of the student's committee must be an IQ Biology faculty member.

Last Updated: 16-Aug-12

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### IQ Biology Certificate Program Outline

**Application Process:**
- Apply to certificate program & to 3 possible home depts.
- Flexible curriculum in 1st year defined by student & IQ Biology Advising Committee.
- Three 10 wk rotations over 9 mo in at least 2 depts, modeled after MCDB/Biochem.
- Students will have a space to sit together in the JSC Biotech Bldg during their 1st year.

<table>
<thead>
<tr>
<th>1st</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year:</td>
<td>IQ Biology Core (6 credits)</td>
<td>IQ Biology Core (6 credits)</td>
</tr>
<tr>
<td>Funded by IQ Biology</td>
<td>CIMB/IQ Biology Seminar (1)</td>
<td>CIMB/IQ Biology Seminar (1)</td>
</tr>
<tr>
<td>Research rotation (TBD)</td>
<td>IQ Biology elective (3)</td>
<td>IQ Biology elective (3)</td>
</tr>
</tbody>
</table>

**MCD Biology Department**

<table>
<thead>
<tr>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>at least one rotation with MCDB Faculty</td>
<td></td>
</tr>
</tbody>
</table>

**Choose dept. & advisor by end of spring semester.**

| Summer between 1st and 2nd year: Conduct research in chosen lab |

<table>
<thead>
<tr>
<th>2nd</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year:</td>
<td>CIMB/IQ Biology Seminar (0)</td>
<td>CIMB/IQ Biology Seminar (0)</td>
</tr>
<tr>
<td>Funded by IQ Biology</td>
<td>5230 Gene Exp. (3)</td>
<td>5210 Cell St.&amp;Funct. (3)</td>
</tr>
<tr>
<td>5776 Sci Ethics (1)</td>
<td>5250* Meth&amp;Log(3)</td>
<td>present in MMB</td>
</tr>
</tbody>
</table>

**Qualifying Exam**

| Summer between 2nd & 3rd year: Assigned to mentor a 1st year IQ Biology student |

<table>
<thead>
<tr>
<th>3rd</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year:</td>
<td>CIMB/IQ Biology Seminar (0)</td>
<td>CIMB/IQ Biology Seminar (0)</td>
</tr>
<tr>
<td>5220* Meth&amp;Log(3)</td>
<td>present in MMB</td>
<td></td>
</tr>
<tr>
<td>TA+orientation</td>
<td>TA (year flexible)</td>
<td></td>
</tr>
<tr>
<td>Comp Exam</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Summer b/w 3rd&4th year: Organize student symposium |

<table>
<thead>
<tr>
<th>4th</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year +</td>
<td>CIMB/IQ Biology Seminar (0)</td>
<td>CIMB/IQ Biology Seminar (0)</td>
</tr>
</tbody>
</table>

**Notes on Differences From the Traditional MCDB PhD Program:**

- Count the IQ Biology rotations as credit toward MCDB rotation credit in the first year.
- 6 credits of IQ Biology Core courses and 6 credits of IQ Biology electives (taken in student’s 1st yr) will count toward the departmental elective courses.
- Allow IQ Biology students to TA in a year other than their 1st year.
- Postpone the deadline of the qualifying exam till the end of the 2nd year.
- Postpone the deadline of the comprehensive exam till the end of the third year.
- *Allow the IQ Biology students to take the comp prep courses out of order.*
- Allow some IQ Biology students to take the MCDB Core Course (~1-4/yr)
- At least one member of the student’s committee must be an IQ Biology faculty member.

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Physics

IQ-Bio Certificate Program Outline

<table>
<thead>
<tr>
<th>Application Process:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply to program &amp; to 3 possible home depts.</td>
</tr>
<tr>
<td>Flexible curriculum in 1st year defined by student &amp; IQ-Bio Advising Committee.</td>
</tr>
<tr>
<td>Three 10 week rotations over 9 months in at least 2 departments modeled after MCDB/Biochem.</td>
</tr>
<tr>
<td>Students will have a space to sit together in the Systems Biotech Building during their 1st year.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1st Year:</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IQ-Bio Core (6 credits)</td>
<td>IQ-Bio Core (6 credits)</td>
<td>Count IQ-Bio Core toward required coursework</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Funded CIMB/IQ-Bio Seminar (1)</td>
<td>Funded CIMB/IQ-Bio Seminar (1)</td>
<td>Count IQ-electives toward dept electives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>by fill b/g gap course (3)</td>
<td>by fill b/g gap course (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IQ-Bio research rotation (#?)</td>
<td>IQ-Bio research rotation (#?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Choose dept. &amp; advisor by end of spring semester.</td>
<td>ok</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>2nd Year:</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer between 1st and 2nd year: Conduct research in chosen lab</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Funded CIMB/IQ-Bio Seminar (0)</td>
<td>Funded CIMB/IQ-Bio Seminar (0)</td>
<td>7310 E&amp;M I (3)</td>
<td>7230 Stat. Mech. (3)</td>
</tr>
<tr>
<td></td>
<td>by</td>
<td></td>
<td>5250 Quantum I (3)</td>
<td>Scientific Ethics (1)</td>
</tr>
<tr>
<td></td>
<td>IQ-Bio</td>
<td>research (#?)</td>
<td>research (#?)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comps I: completion of coursework</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3rd Year:</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer between 2nd &amp; 3rd year: Assigned to mentor a 1st year IQ-Bio student</td>
<td></td>
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</tr>
<tr>
<td>Present at IQ-Bio Student Symposium</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CIMB/IQ-Bio Seminar (0)</td>
<td>CIMB/IQ-Bio Seminar (0)</td>
<td>research (#?)</td>
<td>research (#?)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comps II</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>4th Year+:</th>
<th>1st Semester</th>
<th>2nd Semester</th>
<th>1st Semester</th>
<th>2nd Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer b/w 3rd &amp; 4th year: Organize student symposium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CIMB/IQ-Bio Seminar (0)</td>
<td>CIMB/IQ-Bio Seminar (0)</td>
<td>research (#?)</td>
<td>research (#?)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comps III: between 2nd and 6th year</td>
<td></td>
</tr>
</tbody>
</table>

Notes on Differences From the Traditional Physics PhD Program:

13 credits from outside of Physics will be accepted toward the 30 graduate course credits required.
Comp I exams completed by passing (w/ a B- or higher) 1st sem. IQ-Bio Core, E&M I, Stat. Mech., & Quant. I
Comp II exams must be completed by the end of the 3rd year.

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Section II:

The University of Colorado Boulder

Vision for 2030: The University of Colorado at Boulder will become a leading model of the "new flagship university" of the 21st century—by redefining learning and discovery in a global context and setting new standards in education, research, scholarship, and creative work that will benefit Colorado and the world.
New Student Information

From Acceptance to Enrollment

Applicants will be informed in writing of their acceptance status in March. Students who have been accepted are asked to sign and return their acceptance letter no later than April 15. IQ Biology will notify the pre-approved departments of your acceptance and you will receive an email from them asking you to confirm your “intent to enroll” online. Once you have completed this process, you will be able to register for your IdentiKey, your CU email address, apply for your Buff OneCard, register for classes (we will take care of registration for you) etc.

Acceptance will require you to make a $200 tuition deposit. You may accept the offer via email to us, and then you must go to the Bursars site to pay your $200 deposit. You will be listed as accepted by the department of your admittance.

How to set up an account with the Bursar’s Office

SET UP DIRECT DEPOSIT FOR BURSAR’S REFUND CHECKS

If you’re expecting a refund check from the Bursar’s office, be sure to set up a direct deposit account, even if you already have a direct deposit account with payroll. Payroll is managed through a different system than tuition refunds. For details, visit the Bursar’s website.

Before Classes Start

Once you have enrolled at CU, there will be a lot to do before you actually arrive! If you are new to CU-Boulder, please complete these action items as soon as possible (it is possible to complete these items prior to arriving at the university):

☐ Activate your CU Login Name and IdentiKey Password (link).
☐ Activate your CU-Boulder email (link).
☐ Apply for and submit a photo for your Buff OneCard(link). The Buff OneCard is your key to most services and events at CU. (If you do not want to submit a photo the BuffOne Card Office will take your picture).
☐ Get your RTD College Pass (link) You may do this when you get your BuffOne card. The service for the RTD bus pass is in the same office.
☐ Submit immunization records to Wardenburg Heath Center using (link).
☐ Check out the CU-Boulder campus map (link).
Registering for Classes:

- If you are a new student, we will complete your first semester registration for you.
- Become familiar with the MyCUinfo System [link] and the registration process.
- Unless already a Colorado State resident, all students must complete the Tuition Classification Information [link] so that you qualify for in-state tuition at the end of your first year at CU-Boulder.

Before your classes begin, all students should complete these action items:

- Waive or sign up for health insurance [link]. The IQ Biology program will pay full insurance fees for incoming students in the first and second years. Your department will pay a portion of insurance fees after that.
- Get your Colorado driver’s license and register to vote in Colorado.
- Download a current version of Microsoft Office [link]—this software is available for free once you are on CU payroll (optional).
- Register your bike [link] online or at either of the Bike Stations [link]. The UMC Bike Station is located at the Northwest corner of the UMC by Hellem’s Arts and Sciences and the Folsom Bike Station is located at the southwest corner of the Engineering Center. For more information..

Moving to Boulder

You may wish to begin looking for housing before you arrive. Below are some resources:

- Off Campus Housing Office [link] (UMC 313(map), 303-492-7053)
- Graduate Housing [link]. These provide separate housing options for graduate students and for students who need family housing. This may be an easier way to find affordable housing closer to campus.
- Craig’s List-Boulder [link]. Many students use this as a resource but remember to do your research before you sign a lease.
- Boulder Housing Helpers [link]. Search rental properties including houses, condos, apartments, homes for rent and rentals in Boulder.
- Rent Boulder Now [link]. They have a lot of experience Search rental properties including houses, condos, apartments, homes for rent and rentals in Boulder.

Boulder, Colorado is a wonderful place to live and explore. Below are some useful links.

- City of Boulder homepage: http://www.bouldercolorado.gov/
- State of Colorado homepage: https://www.colorado.gov/
New Student Orientation

Incoming students are required to participate in the IQ Biology Orientation and Bootcamp that takes place prior to the beginning of fall semester. During this time, students are introduced to the City of Boulder, the University, the IQ Biology program and the students and staff of our participating departments. Specific activities include orientations run by IQ Biology and The Graduate School, meetings with the Academic Advising Committee, a student-only dinner, a BioFrontiers picnic, and a subject-based bootcamp.

The bootcamp (see Bootcamp section under Curriculum) is an opportunity for students to get up-to-speed in preparation for the fall core courses. Students will not be strong in all subject areas. Based on a brief assessment, students will take bootcamp-style courses in mathematics, computation, and biology.

To give students an idea of what is to come, IQ Biology will send in July sample questions, a list of references and resources, as well as an agenda for the orientation/bootcamp week.

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Establishing In-state Residency

NOTE: If you are an out-of-state domestic student, you must take action following your move to Colorado to acquire documentation required to establish state residency. Complete instructions and required documents can be found at the Office of the Registrar:
http://www.colorado.edu/registrar/students/state-residency

It takes exactly one year to gain residency. It is important that you begin this process as soon as possible following your move to Colorado; non-resident status may affect the possibility of future funding opportunities, as non-resident tuition waivers are substantially more expensive than resident waivers. Please see Appendix D for a checklist.

Because domicile is defined as a true, fixed, and permanent home, persons who are physically present in Colorado only on a temporary basis cannot establish domicile merely by taking these actions. Thus, establishing a new domicile requires actual residence on a permanent basis.

As specified by law, the Tuition Classification Officer considers the following evidence (and any additional relevant information) when evaluating requests for in-state tuition.

- Payment of Colorado state income tax (if your income is sufficient to be taxed). All taxable income accrued after you move to Colorado, regardless of source, must be reported to the Colorado Department of Revenue. You should file part-year resident returns for each state of residence for the year you move into Colorado. For subsequent years, you should file a full-year resident Colorado return and a nonresident return for any other state in which you are required to file. For additional information, contact the Colorado Department of Revenue, 1375 Sherman Street, Denver, CO 80203; telephone 303-238-7378.

- Colorado driver’s license. If you have a driver’s license from another state, you must apply for a Colorado driver’s license within 30 days of moving to Colorado (if you are employed) or within 120 days (if unemployed). If you do not drive, you may obtain a Colorado identification card. These documents are available from the Driver’s License Division, located in Boulder at 28th Street and Iris Avenue; telephone 303-442-3006. For the identification requirements for a Colorado license or ID, see http://www.revenue.state.co.us/mv_dir/faqdrli/mv_dir/faqdrli1

- Colorado vehicle registration. If you operate a motor vehicle, you must register it in Colorado within 180 days of moving to Colorado. Contact your county clerk for vehicle registration. Boulder County vehicle registration information is available from the County Clerk, 1750 33rd St.; telephone 303-413-7710

- Voter registration in Colorado. You may register to vote with your county clerk, or when you obtain your Colorado driver’s license, as soon as you move into the State. Boulder County voter registration information is available from the County Clerk, 1750 33rd St.;

- **Permanent employment** or acceptance of future permanent employment in Colorado.
- **Ownership of residential real property in Colorado that is your primary residence.** Ownership of vacation or income property is not an indication of domicile.
- **Graduation from a Colorado high school.**
- **Continued residence in Colorado** during the summer or during other periods when not enrolled as a student or during periods between academic sessions.
- **Other factors particular to your situation** may be considered also, and should be documented.
Facilities and Computing

Card Access
Your Buff OneCard is your key to all kinds of services and events here at CU-Boulder. It is necessary for admittance to the Recreation Center, checking out library books, printing, and most importantly for building access after-hours and on weekends. The Buff OneCard office is located in the Center for Community (C4C) room N180. They can also be reached by phone at 303-492-0355. More information is available at the Buff OneCard website.

Computing Facilities
There are several computer labs across campus available to students. Lab access may be limited to certain program members have restricted hours. The Office of Information Technology has availability information for all computer labs here: http://webdata.colorado.edu/labs/map/
While not yet listed on this map there is a computer lab in JSCBB A205 that is open to all CU Boulder students.

Mailbox
You will each have a mailbox in the BioFrontiers Administrative Office Suite. Please make sure you check this periodically. Please do not have personal mail sent here because we cannot guarantee the security of it.

Office and Desk Space
So that students can become familiar with the different labs and researchers, students are encouraged to “set up shop” in the lab in which they are currently conducting rotation research. The Caruthers Biotechnology Building also houses a collaboration room dedicated to the IQ Biology program. Students are provided with 24-hour access to this space and are provided with lockable cabinets to keep any personal items.

Please note that because this room is intended for the exclusive use of the IQ Biology program and because it will hold personal items, it is imperative that the room be locked at all times. We also ask that the students be courteous as this is a shared space. Some simple rules to be observed:
- Keep table tops free of clutter;
- Clean up any messes (sink, counter tops, refrigerator, microwave, etc.);
• Keep the door locked when the room is empty; and
• Keep noise to a minimum (respect others who are working).

Parking and Transportation

Driving/Parking

Parking and Transportation Services (PTS) helps students and their visitors with their transportation needs with an emphasis on safety and sustainability. They provide options for car sharing, student shuttles, bike programs, carpool, and permit parking.

Academic Year Permits: There are two types of student permits available. These are Campus Resident and Commuter. Permit rates vary based on the proximity of the lot to campus and duration of the permit. You will need your IdentiKey, password, and vehicle registration to purchase a permit.

Parking Maps: http://www.colorado.edu/parking/maps/

Riding the Bus

RTD Student Pass: The RTD Student Eco-Pass provides free rides to all local and regional RTD buses, including SkyRide to DIA, and light-rail. All students paying tuition can pick up their pass at the Buff OneCard office at Center for Community (C4C) N180.

Buses: Most buses run every 10 to 15 minutes during peak hours on weekdays and weekends.

• The Buff Bus – runs from main campus to Williams Village (operated by CU)
• The Hop – connects downtown, University Hill, campus, and the 29th Street Mall
• The Dash – runs along South Boulder from Lafayette to Louisville to Boulder
• The Stampede – runs along Colorado Ave, 30th, and connects to main campus
• The Skip – runs north and south along Broadway from Front Range to Greenbriar Blvd.
• The Bound – runs from Iris to Baseline and along 30th
• The Flatiron Flyer – goes to Denver
• AB – goes to the Denver International Airport

For schedules and routes, download this mobile app or visit RTD to find schedules.
Biking

The Bike Station provides a place for students to register, repair, borrow, or get advice about bikes and pick up maps for paths around Boulder.

Boulder B-cycle hosts 40 stations and 300 bikes throughout Boulder County, www.boulder.bcycle.com

CU-Boulder’s Environmental Center also has information on alternative modes of transportation and has bikes available for rent.

www.gobikeboulder.net provides information about biking in the city of Boulder.

Getting to Anschutz Medical Center

Driving:
Typical Directions from Boulder to Anschutz:
2. Continue onto I-270 E for about 8 minutes (6.8 miles)
3. Merge onto I-70 E for about 2 minutes (1.3 miles)
4. Take exit 281 to merge onto Peoria St. for about 3 minutes (1.6 miles)
5. Turn left onto Fitzsimons Pkwy. For about 2 minutes (0.9 miles)
6. Take the 1st right onto Victor St.
7. Take the 1st right onto E 23rd Ave.
8. Take the 1st right onto N Ursula St.
9. Arrive at University of Colorado Hospital: University Medicine-Anschutz Medical Campus N Ursula St, Aurora, CO 80045

Expected Travel Time: 50 minutes

Parking at Anschutz: University of Colorado faculty, staff and students who have a valid parking permit (or comparable official parking identification) may park at the Anschutz campus when on official university business or classes. The CU reciprocal parking arrangement is valid for specific designated reciprocal parking lots only and availability is based on “first-come, first-serve” basis. You may also pay to park in one of the visitor lots and motorcycle parking is also available. Students taking courses at Anschutz who do not have a pass at CU-Boulder can purchase short-term CU-Boulder parking and use the reciprocal parking lots at Anschutz.
**Public Transportation:**
RTD offers direct transportation between Boulder and Anschutz Medical Campus via the Flatiron Flyer Route FF5. It is recommended you use RTD’s Trip Planner for precise route and time information as bus schedules have some day-to-day variance. The Trip Planner can be found at [http://www.rtd-denver.com/](http://www.rtd-denver.com/) and has drop down boxes for transport between the University of Colorado at Boulder and Anschutz Medical 9th Ave campus, Fitzsimons Campus, and Medical Center.

Expected Travel Time: 1.5 to 2 hours.
Human Resources
New students will be asked to provide documents so that human resources (HR) can set you up in the payroll system. You will be asked to provide a completed I-9 form; a completed W-4 form; a current passport OR driver’s license, AND social security card. If you have questions about this process please contact Amber McDonnell or Lee Gutmacher who will put you in contact with the appropriate departmental representative.

Health Care Information
You will be automatically enrolled in the Wardenburg GOLD plan. IQ Biology will pay the premium for the first two years. Years three and after will be either partially or fully paid for by your department, depending on their policies. For more information on Wardenburg GOLD, please click here.
Graduate Student Resources

The Graduate School
Graduate students should visit the [graduate school website](#) for any information about graduate life including academic forms, calendar events, and information about funding, professional development, policies, and various resources. Incoming students should complete a recommended [checklist](#) of items and tasks posted on the website.

United Government of Graduate Students (UGGS)
The United Government of Graduate Students is the primary advocacy group for graduate and professional students on the CU-Boulder campus. UGGS is committed to enhancing the graduate student experience at the University by interacting with the University administration and the University of Colorado Student Union (UCSU) concerning issues such as financial aid, graduate stipends, health care, tuition and fees and graduate student well-being. Graduate students from each department and program are solicited to serve on the UGGS Assembly, ensuring a diverse and complete representation of the graduate student body.
Visit: [http://uggs.colorado.edu/](http://uggs.colorado.edu/).

The Writing Center-Norlin Library
Offers writers from across disciplines and skill levels the opportunity to work one-on-one with consultants trained in writing pedagogy. [Writing Center](#) sessions strive to address writers' stated needs while attending to relevant disciplinary, rhetorical, grammatical, and stylistic concerns. Consultants provide feedback and advice that promote writers' abilities to communicate successfully and think critically in the complex and changing environments of the university, the workplace, and society.

The Office of Victim Assistance
The Office of Victim Assistance (OVA) offers free confidential information, counseling, advocacy and support to all University of Colorado Boulder students, staff, and faculty impacted by potentially traumatic or life disruptive events.
303-492-8855
Counseling and Psychiatric Services (CAPS)
CAPS offers confidential, on-campus mental health and psychiatric services for a variety of concerns such as academics, anxiety, body image, depression, relationships, substance use and more.
http://www.colorado.edu/health/counseling
303-492-6766 and 303-492-5654

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Honor Code
CU students are expected to abide by a student-run honor code. The Honor Code Committee consists of representatives from the student body, the faculty, and the administration with the purpose of curbing academic dishonesty while building the campus community. Unacceptable behavior regarding plagiarism, cheating, fabrication, aid or academic dishonesty, lying, bribery, and threats are all outlined here.

Classroom Behavior
Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran's status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationality. Class rosters are provided to the instructor with the student's legal name. Your instructors will gladly honor your request to address you by an alternate name or gender pronoun. Please advise them of this preference early in the semester so that they may make appropriate changes to my records. Policies can be viewed here and the student code is available here.

Disability Services
Disability Services offers various accommodations to students eligible for assistance. Accommodations include extended time on exams, distraction-reduced testing environment, readers, interpreters, note takers, alternative text formats such as audio books or Braille, and more. To qualify students must demonstrate need by showing documentation with proof of disability. More information is available at the Disability Services website.
Religious Accommodations
Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Instructors may have a different set of policies in place for each course. Full details are available online.

Discrimination and Harassment
The University of Colorado at Boulder Discrimination and Harassment Policy and Procedures, the University of Colorado Sexual Harassment Policy and Procedures, and the University of Colorado Conflict of Interest in Cases of Amorous Relationships policy apply to all students, staff, and faculty. Any student, staff, or faculty member who believes s/he has been the subject of sexual harassment or discrimination or harassment based upon race, color, national origin, sex, age, disability, creed, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Student Conduct (OSC) at 303-492-5550. Information about the ODH, the above referenced policies, and the campus resources available to assist individuals regarding discrimination or harassment can be obtained here.
Contact Information

IQ Biology
BioFrontiers Institute,
University of Colorado Boulder
3415 Colorado Avenue
Campus Box 596 UCB
Boulder, CO 80309-0596
303-735-7616
IQBiology@colorado.edu

Education Programs Manager
Amber McDonnell
Office: A171C JSCBB
303-735-7508
email

Assistant Director for Interdisciplinary Education
Andrea Stith, PhD
Office: A171S JSCBB
303-735-7503
email

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Appendix A: IQ Biology Certificate Full Checklist

**Student Information**

Name: ____________________________  
Year Entered Program: ________________  
SID: ________________________________  
E-mail: ________________________________  
Degree Program: _____________________  
Primary Advisor(s): ____________________  
Committee Members: ____________________  
Out-of-discipline IQ Biology faculty member(s): ____________________  
Other IQ Biology faculty members (optional): ____________________

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**Course Requirements** (Must receive a B- or better for each course.)

FIRST YEAR FALL SEMESTER
- [ ] Core Course: Quantitative Optical Imaging (4 credit hours)
- [ ] First IQ Biology Research Rotation (3 credits)
- [ ] 1st Gap-Filling Course (3 credits)

FIRST YEAR SPRING SEMESTER
- [ ] Core Course: Bioinformatics and Genomics (4 credit hours) OR Manual Lladser Mathematical and Computational Biology (4 credit hours)
- [ ] Core Course: Cells, Molecules and Tissues, a Biophysical Approach (3 credit hours) OR Biophysics (4 credit hours)
- [ ] 2nd and 3rd IQ Biology Research Rotations (3 credit hours)
- [ ] 2nd Gap-Filling Course (3 credit hours) (optional)

All domestic graduate students must file for residency with the university.

*http://www.colorado.edu/registrar/state-tuition*

COMPLETE BY END OF 2ND YEAR
- [ ] Ethics Course or Workshop

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**Research Requirements**

FIRST YEAR
- [ ] Three 10-week research rotations in at least two disciplines/departments
  - Rotation I Lab ________________  
  - Rotation II Lab ________________  
  - Rotation III Lab ________________  
  - Presentation Date ________________

MAY OF 1ST YEAR
- [ ] Choose Degree Program—Choose any degree program you were pre-approved for, or any other by arrangement. Which degree program? ____________________
  Meet with graduate chair and advisor of chosen department before May 15 of 1st year.

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EACH YEAR
☐ Thesis Committee Meetings – Must be held every year and include an out-of-discipline IQ Biology Faculty member. Year 2: ________, Year 3: ________, Year 4: ________, Year 5: ________, Year 6: ________.
Out of discipline faculty member ________________________________

BEFORE GRADUATION
☐ Dissertation – Complete a Ph.D. in accordance to the specified degree program rules and the MOU modifications to those rules (including coursework, teaching, exams, etc.).
Which degree program? ________________________ Advisor(s): ________________________
Title of Dissertation: _______________________________ Date Completed __________

Activity Requirements

FIRST YEAR
☐ IQ Biology Academic Advising Meetings – Meet with the IQ Biology Academic Advising three times in your 1st year: just before classes start in August, in November/December of the fall semester, and in March/April of spring semester.
August (meeting Date): ________, Nov/Dec: ________, Mar/Apr: ________

☐ IQ Biology Idea Exchange – Participate in the bi-weekly activities. Students will participate in the IQ Biology Idea Exchange 1-2 times each month following their first year.

EACH YEAR
☐ IQ Biology Seminar Series – Must attend IQ Biology weekly seminars and the pre-seminar meeting with guest speaker (if scheduled).

☐ IQ Biology Symposium – Must attend every other year.
☐ Help organize in 3rd year. Submit abstract every year, starting in 3rd year.
☐ Year 3 (abstract title): ________________________________
☐ Year 4 (abstract title): ________________________________
☐ Year 5 (abstract title): ________________________________
☐ Year 6 (abstract title): ________________________________

BEFORE GRADUATION
☐ Outreach – Must participate in at least one outreach activity pre-approved by IQ Biology Academic Advising. Approved activity: ________________________________ When it was approved: ____________ When completed: ____________

☐ Teaching (optional) – IQ Biology does not have a specific teaching requirement, but your chosen degree program may have a requirement. There are opportunities for students to teach in the IQ Biology core courses if you are interested.
Courses taught: ________________________________
Internship (optional)—Usually done in the summer between the 1st and 2nd or 2nd and 3rd years.
Internships done:

Notes

Exceptions:
Requests for exceptions to these requirements must be made in writing to the Academic Advising and approved by the Academic Advising. For example, a student may want to request to take a gap-filing course or ethics course after her/his 1st year if the course is only offered every other year.

Clarification of “New” versus “Current” Students:
“New” students are those joining IQ Biology in their 1st year as a graduate student; most of our incoming students are new students. “Current” students are already pursuing a Ph.D. in one of our participating departments and have joined IQ Biology sometime after their 1st year.

Current students are required to complete all of the above items EXCEPT:
- They are only required to take up to one gap-filling course (as determined by the IQ Biology Academic Advising).
- They are not required to do research rotations.
- They are not required to take an ethics course or workshop, unless their degree program requires one.
- They have already chosen their degree program.
- They must complete their degree according to the rules set out in their degree program guidelines (the MOUs with IQ Biology do not apply).
- Their participation in the Core Courses and Idea Exchange will take place in their 1st year in the IQ Biology program, rather than their 1st year as a graduate student.
- Occasionally, current students may have successfully petitioned (on their application) that previous related coursework would count in place of one of the Core Courses.
Appendix B: Memorandums of Understanding (MOUs)

Re: Memorandum of Understanding
Alterations to Applied Mathematics PhD program to permit inclusion of Interdisciplinary Quantitative Biology (IQ-Bio) Certificate Program students

To: Todd Gleeson, Dean of the College of Arts and Sciences
   James Curry, Chair and Professor of Applied Mathematics
   James Meiss, Associate Chair for Graduate Studies, Professor of Applied Mathematics

From: Vanja Dukic, IQ-Bio Faculty Member, Associate Professor of Applied Mathematics
   Manuel Lladser, IQ-Bio Faculty Member, Assistant Professor of Applied Mathematics
   David Bortz, IQ-Bio Faculty Member, Assistant Professor of Applied Mathematics
   Juan Restrepo, IQ-Bio Faculty Member, Assistant Professor of Applied Mathematics
   Tom Cech, IQ-Bio Director, CIBM Director, Professor of Chemistry and Biochemistry
   Leslie Leinwand, IQ-Bio Faculty Member, Professor of MCDB

Date: 29 November 2010

This memorandum is the enabling document for the inclusion of students from the Interdisciplinary Quantitative Biology (IQ-Bio) Certificate Program in the CU-Boulder Applied Mathematics PhD program. These students will receive their certificate from the Graduate School and their PhD from the Applied Mathematics PhD Program.

The Faculty of the Applied Mathematics Department has approved the statement below, which appears in the Department’s Graduate Guidelines and in the IQ-Bio Graduate Guidelines:

IQ-Bio Certificate Program students will be able to fulfill the Applied Mathematics portion of their PhD requirements as per Applied Mathematics policy with the following provisions:

- The first year of courses will count towards the required out-of-department credits (passing with a B- or above). They include: both semesters of IQ-Bio Core, and up to two other graduate level courses as determined by the IQ-Bio Advising committee.
- IQ-Bio students will take the following preliminary exams and associated coursework as necessary: Numerical Analysis, Applied Analysis, and Probability & Statistics.
- The deadline for the comprehensive oral thesis proposal will be postponed until the end of the third year.
- The student’s thesis committee will include an IQ-Bio faculty member.
**Program Explanation**
The following sections describe the program.

**Goal**
The Department of Applied Mathematics is delighted to participate in the IQ-Bio Certificate program. Some of the students who enter the IQ-Bio program will choose to get their PhD degree in Applied Mathematics. The addition of an interdisciplinary certificate should not delay a participating student's graduation by more than one semester.

**Background**
Increasingly, addressing multifaceted problems in quantitative biology requires interdisciplinary collaboration. Faculty from eight departments across two schools at UC Boulder came together to develop a Ph.D. certificate program to train students to use quantitative methods to solve bioscience problems.

Students recruited into the program are selected based on their capabilities and their interdisciplinary interests. Each incoming class of students is chosen to cover a diverse set of disciplines. The students apply directly to the program and potential home departments simultaneously. They work with the other IQ-Bio students during the first year of the program. Students participate in research rotations in multiple departments. They also engage in a two-semester core course, where they work in teams to learn quantitative techniques and biological applications. In May of the first year, students choose a home department to acquire deep training within a discipline.

Many faculty from multiple departments are interested in using this program as a way to attract high caliber interdisciplinary students interested in quantitative biology. The departments involved in developing the program are: Physics (Betterton), Molecular, Cellular, Developmental Biology (Perkins, Dowell), Chemistry and Biochemistry (Cech, Knight, Yin, Palmer), Applied Mathematics (Bortz, Dukic, Lladser, Restrepo), Environmental and Evolutionary Biology (Melbourne), Mechanical Engineering (Ferguson), Chemical and Biological Engineering (Anseth, Bryant), and Computer Science (Goldberg).

**Role of Applied Mathematics Faculty in IQ-Bio Program Administration**
A Steering Committee consisting of at least one representative from each of the participating departments will meet at least once a year to oversee the IQ-Bio certificate program. Subgroups of this committee will oversee the recruitment, admissions, and advising of students in the program. Faculty interested in mentoring students will be listed as possible rotation opportunities for incoming students.

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Number of Students
The IQ-Bio program admits from six to twelve students per year. The Applied Mathematics Department might matriculate up to two of these students each year.

Admissions
The IQ-Bio program faculty and the graduate committees in participating departments carry out admissions to the IQ-Bio program. Students apply directly to the IQ-Bio program and are first evaluated by the IQ-Bio Admissions Committee. Applications that are approved are forwarded to the relevant departmental graduate admissions committees. Students are encouraged to indicate three departments in which to apply to. Students must be accepted by at least two departments to be accepted by the IQ-Bio program. IQ-Bio will have its own recruitment event, where applicants are available to meet with departmental faculty as needed. Applications that are approved by two departments and the IQ-Bio Admissions Committee are officially submitted through the graduate school admission process.

In the first year, accepted students are nominally enrolled in one of their possible home departments; however, IQ-Bio faculty members working with relevant departments determine which department is ultimately the student's home department.

Course Work
Required Graduate Courses for Applied Math. PhD students with an IQ-Bio Certificate:

First Year
• IQ-Bio Core 1st semester (6 credits)
• IQ-Bio Core 2nd semester (6 credits)
• One to two other graduate courses to fill gaps in background related to quantitative biology as determined by the IQ-Bio Advising Committee (3-8 credits)

Second and Third Year
• Applied Analysis series (6 credits, APPM 5440, APPM 5450)
• Numerical Analysis series (6 credits, APPM 5600, APPM 5610)
• Probability and Statistics series (6 credits, APPM 5520 and APPM 5560)
• A scientific ethics course (1 credit, e.g., CHEM 5776)

For the IQ-Bio students, Applied Mathematics understands that 12 of the 30 required credits are taken outside of the Applied Mathematics Department in courses appropriate for the student's research (from a combination of 1st semester IQ-Bio core, 2nd semester IQ-Bio Core, and other gap-filling courses).

Teaching Assistant Requirements
Teaching Assistant requirements remain the same as defined by Applied Mathematics policy.
Students must pass three preliminary exams in Applied Mathematics with a research pass in at least two of them. Preliminary exams are given in the following areas:
1) Applied Analysis
2) Numerical Analysis
3) Probability and Statistics

**Comprehensive Oral Thesis Proposal**
IQ-Bio students must take this by the end of their 3rd year.

**Dissertation Research**
Dissertation research is carried out in Applied Mathematics under the direction of a member of the Graduate Faculty. The student's thesis committee must include at least one IQ-Bio faculty member.

**Dissertation Defense**
The oral defense of a written doctoral dissertation is carried out in Applied Mathematics as defined by Applied Mathematics policy.

*Original signed MOU available from IQ Biology upon request.*

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Re: Memorandum of Understanding

Alterations to the Biochemistry Ph.D. program to permit inclusion of Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program students

To: Sue Beatty, Ph.D., Assoc. Dean Natural Sciences in the College of Arts and Sciences
Bruce Eaton, Ph.D., Chair and Professor of Chemistry and Biochemistry
Deborah Wuttke, Ph.D., Acting Biochem. Division Chair, Prof. of Chem. & Biochem.
Robert Batey, Ph.D., Chair Graduate Studies, Assoc. Prof. Chemistry & Biochemistry

From: Amy Palmer, Ph.D., IQ Biology Faculty Member, Asst. Prof. of Chem. & Biochem.
Hubert Yin, Ph.D., IQ Biology Faculty Member, Asst. Prof. of Chem. & Biochem.
Rob Knight, Ph.D., IQ Biology Faculty Member, Assoc. Prof. of Chem. & Biochem.
Tom Cech, Ph.D., IQ Biology Director, CIMB Director, Prof. of Chem. & Biochem.
Leslie Leinwand, Ph.D., IQ Biology Faculty Member, CIMB CSO, Prof. of MCDB

CC: Art Pardi, Ph.D., Biochem. Division Chair (on Sabbatical), Prof. of Chem.& Biochem.
Jana Watson-Capps, Ph.D., Assistant Director of Interdisciplinary Education, CIMB

Date: 08 February 2011

This memorandum is the enabling document for the inclusion of students from the Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program in the CU-Boulder Biochemistry Ph.D. program. These students will receive their certificate from the Graduate School and their Ph.D. from the Biochemistry Ph.D. Program.

The Faculty of the Biochemistry Division of the Chemistry and Biochemistry Department have approved the statement below, which appears in the Department's Graduate Guidelines and in the IQ Biology Graduate Guidelines:

“IQ Biology Certificate Program students will be able to fulfill the Biochemistry portion of their Ph.D. requirements if the following are completed:

Courses:
IQ Biology
• First semester of IQ Biology Core (6 credits)
• Both second semester IQ Biology Core courses (3 credits each)
• Up to 2 other graduate level quantitative biology courses as determined by the IQ Biology Advising Committee

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Biochemistry

- Biochemistry Core: CHEM 5771 (5) and CHEM 5781 (5)
- Participation in Biochemistry Seminar
- Scientific Ethics CHEM 5776 (1)
- A possible graduate-level elective course determined by the student’s committee based on the student’s background.
- Any additional approved graduate-level coursework to add up to 30 credits.
- At least 30 doctoral dissertation hours

All courses must be passed with a B- or higher.

Comprehensive Exam: taken by the end of the student’s 2nd year. If the student needs to re-take the comprehensive exam, it will be done in December of the student’s 3rd year.

Oral Exam: taken in July after the student’s 2nd year. The orals committee will include at least one faculty member from outside the department, at the advisor’s discretion. The outside committee member will participate in the exam, but not vote.

Dissertation Research and Defense: These will occur as defined within Biochemistry policy, with the following change: at least one member of a student’s committee must be an IQ Biology faculty member.”

Explanation of the program:

Goal: Biochemistry would like to participate in the IQ Biology Certificate program. Some of the students who enter the IQ Biology program will choose to get their Ph.D. degree in Biochemistry. The addition of an interdisciplinary certificate should not delay a participating student’s graduation by more than one semester.

Background:

Addressing multifaceted problems in quantitative biology requires interdisciplinary collaboration. Faculty from eight departments across two schools at CU Boulder have come together to develop a Ph.D. certificate program to train students to use quantitative methods to solve bioscience problems.

Students recruited into the program will be selected based on their capabilities and also their interdisciplinary interests. Each incoming class of students will be chosen to cover a diverse set of disciplines. The students apply directly to the program and potential home departments simultaneously. They work with the other IQ Biology students their first year. Students participate in research rotations in multiple departments and a two-semester core course, in which students work in teams to learn quantitative techniques and their biological applications. In May of their first year, students choose a home department to acquire deep training within a discipline.

Many faculty members from multiple departments are interested in using this program as a way to attract high caliber interdisciplinary students interested in quantitative biology. The departments involved in developing the program are: Physics, MCDB, Chem/Biochemistry, Applied Math, E-Bio, Mechanical Engineering, Chem&Bio Engin, and Computer Science.
Role of Biochemistry Faculty in IQ Biology Program Administration: A Steering Committee consisting of at least one representative from each of the participating departments will meet at least once a year to oversee the IQ Biology certificate program. Subgroups of this committee will oversee the recruitment, admissions, and advising of students in the program. Faculty interested in mentoring students will fill out a short application and can be listed as possible rotation opportunities for incoming students.

Number of Students: The IQ Biology program will admit about 6-12 students per year. The Biochemistry Degree Program might matriculate 0-2 of these students each year.

Admissions: Admissions will be carried out jointly by the IQ Biology program and the participating departments. Students will apply directly to the IQ Biology program and be first evaluated by the IQ Biology Admissions Committee. Applications that have been approved at this step will be forwarded to the relevant departmental admissions committees. Students will be encouraged to indicate three departments they would like to apply to; and students must be accepted by at least two departments (or disciplines) to be eventually accepted by the IQ Biology program. IQ Biology will have its own recruitment event, where applicants can be available to meet with departmental faculty as needed. Applicants who have successfully been pre-approved by two departments (or doctoral programs) and the IQ Biology Admissions committee will be officially admitted to a single department (to be determined by IQ Biology faculty). In their first year, accepted students will nominally be enrolled in this department.

Original signed MOU available from IQ Biology upon request.

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This memorandum is the enabling document for the inclusion of students from the Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program in the CU-Boulder Chemical and Biological Engineering PhD program. These students will receive their certificate from the graduate school and their PhD from the Chemical and Biological Engineering PhD Program.

The Faculty of the Chemical and Biological Engineering Department have approved the statement below, which appears in the Department's Graduate Guidelines and in the IQ Biology Graduate Guidelines:

“IQ Biology Certificate Program students will be able to fulfill the Chemical and Biological Engineering portion of their PhD requirements if the following are completed:

Courses: Both semesters of IQ Biology Core, up to 2 other graduate level quantitative biology courses as determined by the IQ Biology Advising committee, a scientific ethics course, Transport Phenomena (CHEN 5210), Intermediate Chemical Engineering Thermodynamics (CHEN 5370), Chemical Reactor Engineering (CHEN 5390), Analytical Methods for Chemical Engineers (CHEN 5740). All must be passed with a B- or higher. All students entering the program without a degree closely-related to chemical engineering must complete four chemical engineering core undergraduate courses with a grade of B or better (Fluids/Heat, Mass Transfer, Thermodynamics, Kinetics or the equivalent courses) or demonstrate similar competency through mechanisms defined in the Chemical Engineering Graduate Handbook.

Qualifying Exam: The qualifying exam will administered as defined within Chemical & Biological Engineering policy, but the deadline will be postponed to the end of the 2nd semester in the 2nd year.

Comprehensive Exam: The Comprehensive Exam will be administered as defined by Chemical & Biological Engineering policy.

Advanced TA: The Advanced TA will be administered as defined by Chemical & Biological Engineering policy.

Dissertation Research and Defense: These will occur as defined by Chemical and Biological Engineering policy. There will be an extension of the graduate date for IQ Biology students to 5.5 years. An
Explanation of the program:

Goal: Chemical and Biological Engineering would like to participate in the IQ Biology Certificate program. Some of the students who enter the IQ Biology program will choose to get their PhD degree in Chemical and Biological Engineering. The addition of an interdisciplinary certificate should not delay a participating student’s graduation by more than one semester.

Background:

Addressing multifaceted problems in quantitative biology requires interdisciplinary collaboration. Faculty from eight departments across two schools at UC Boulder have come together to develop a Ph.D. certificate program to train students to use quantitative methods to solve bioscience problems.

Students recruited into the program will be selected based on their capabilities and also their interdisciplinary interests. Each incoming class of students will be chosen to cover a diverse set of disciplines. The students apply directly to the program and potential home departments simultaneously. They work with the other IQ Biology students their first year. Students participate in research rotations in multiple departments and a two-semester core course, in which students work in teams to learn quantitative techniques and their biological applications. In May of their first year, students choose a home department to acquire deep training within a discipline.

Many faculty from multiple departments are interested in using this program as a way to attract high caliber interdisciplinary students interested in quantitative biology. The departments involved in developing the program are: Physics (Betterton, Glaser), MCDB (Perkins, Dowell, Leinwand), Chem/Biochem (Cech, Knight, Yin, Palmer, Pardi, Nesbitt), Applied Math (Lladser, Bortz), E-Bio (Melbourne), Mechanical Engineering (Ferguson), Chem&Bio Engineering (Anseth, Bryant), and Computer Science (Goldberg, Clauset).

Role of Chemical and Biological Engineering Faculty in IQ Biology Program Administration: A Steering Committee consisting of at least one representative from each of the participating departments will meet at least once a year to oversee the IQ Biology certificate program. Subgroups of this committee will oversee the recruitment, admissions, and advising of students in the program. Faculty interested in mentoring students will fill out a short application and can be listed as possible rotation opportunities for incoming student.

Number of Students: The IQ Biology program will admit about 6-12 students per year. The Chemical and Biological Engineering Department might matriculate 0-2 of these students each year.

Admissions: Admissions will be carried out jointly by the IQ Biology program and the participating departments. Students will apply directly to the IQ Biology program and be first evaluated by the IQ Biology Admissions Committee. Applications that have been approved at this step will be forwarded to the relevant departmental admissions committees. Students will be encouraged to indicate three departments they would like to apply to; and students must be accepted by at least two departments (or disciplines) to be eventually accepted by the IQ Biology program. IQ Biology will have its own recruitment event, where applicants can be available to meet with departmental faculty as needed. Applications that have successfully been approved by two departments (or disciplines) and the IQ Biology Admissions committee will be officially admitted to a single department. In their first year, accepted students will nominally be enrolled in this department, but would be funded by the IQ Biology program. The department will be determined by IQ Biology faculty.

Course Work:
Required Graduate Courses for Chemical and Biological Engineering PhD students with an IQ Biology Certificate:
First year
• IQ Biology Core 1st semester (6 credits), could be cross-listed in Chem. & Biol. Engineering
• IQ Biology Core 2nd semester (6 credits)
• 1-2 other graduate courses to fill gaps in background related to quantitative biology as determined by the IQ Biology Advising Committee

Second and Third years
• Transport Phenomena (CHEN 5210)
• Intermediate Chemical Engineering Thermodynamics (CHEN 5370)
• Chemical Reactor Engineering (CHEN 5390)
• Analytical Methods for Chemical Engineers (CHEN 5740)
• A scientific ethics course (e.g., CHEN 5838)

For the IQ Biology students, Chemical and Biological Engineering will accept that 12 of the 30 required credits of 5000-level or above can be taken outside of the Chemical and Biological Engineering Department in courses appropriate for each student’s research. (6 from IQ Biology Core, 6 from gap-filling courses).

Teaching Assistant Requirements: The Advanced TA will be administered as defined by Chemical & Biological Engineering policy.

Qualifying Exam: The qualifying exam will administered as defined with Chemical & Biological Engineering policy, but the deadline will be postponed to the end of the 2nd semester in the 2nd year.

Comprehensive Exam: The Comprehensive Exam will administered as defined by Chemical & Biological Engineering policy.

Dissertation Research: Dissertation research will be carried out in Chemical and Biological Engineering under the direction of a member of the Graduate Faculty. In addition, at least one member of a student’s committee must be an IQ Biology faculty member.

Dissertation Defense: The oral defense of a written doctoral dissertation will be carried out in Chemical and Biological Engineering as defined by Chemical and Biological Engineering policy.

On behalf of our respective entities, we accept these arrangements for IQ Biology certificate program students to also complete the PhD program in Chemical and Biological Engineering and CU-Boulder.

Original signed MOU available from IQ Biology upon request.
Re: Memorandum of Understanding
Alterations to Computer Science Ph.D. program to permit inclusion of Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program students

To: Xiao-ChuanCai, Ph.D., Chair and Professor of Computer Science
Shivakant Mishra, Ph.D., Graduate Committee Chair & Assoc. Professor of CS
Robert Davis, Ph.D., Dean of the College of Engineering and Applied Science

From: Tom Cech, Ph.D., IQ Biology Director, CIMB Director, Prof. of Chem. & Biochem., Leslie Leinwand, Ph.D., IQ Biology Faculty Member, CIMB CSO, Prof. of MCDB

CC: Jana Watson-Capps, Ph.D., Assistant Director of Interdisciplinary Education, CIMB

Date: 23 Nov 2010

This memorandum is the enabling document for the inclusion of students from the Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program in the CU-Boulder Computer Science Ph.D. program. These students will receive their certificate from the graduate school and their Ph.D. from the Computer Science Ph.D. Program.

The Faculty Members of the Computer Science Department have approved the statement below, which appears in the Department's Graduate Guidelines and in the IQ Biology Graduate Guidelines:

“IQ Biology Certificate Program students will be able to fulfill the Computer Science portion of their Ph.D. requirements if the following are completed:

Courses:

IQ Biology
• Entire first semester of IQ Biology Core (6 credit hours)
• Half of the second semester of IQ Biology Core (3 credit hours, cross-listed in CS)

Computer Science
• Minimum of 21 credit hours of CS courses (or courses cross-listed in CS) numbered 5000 or above, in addition to the IQ Biology requirements listed above. Fifteen of these must come from 5 courses in different Areas, which fulfills the CS Breadth requirement. All Breadth-requirement courses must be passed with a B+ or better.
Preliminary Exam: Must take by end of the student’s 3rd year.
Thesis Proposal/Oral Exam: Must take by end of the student’s 4th year.
Dissertation Research and Defense: These will occur as defined within Computer Science policy. In addition, at least one member of a student’s committee must be an IQ Biology faculty member.”

Explanation of the program:

Goal: Computer Science would like to participate in the IQ Biology Certificate program. Some of the students who enter the IQ Biology program will choose to get their Ph.D. degree in Computer Science. The addition of an interdisciplinary certificate should not delay a participating student’s graduation by more than one semester.

Background:

Addressing multifaceted problems in quantitative biology requires interdisciplinary collaboration. Faculty from eight departments across two schools at CU Boulder have come together to develop a Ph.D. certificate program to train students to use quantitative methods to solve bioscience problems.

Students recruited into the program will be selected based on their capabilities and also their interdisciplinary interests. Each incoming class of students will be chosen to cover a diverse set of disciplines. The students apply directly to the program and potential home departments simultaneously. They work with the other IQ Biology students their first year. Students participate in research rotations in multiple departments and a two-semester core course, in which students work in teams to learn quantitative techniques and their biological applications. In May of their first year, students choose a home department to acquire deep training within a discipline.

Many faculty members from multiple departments are interested in using this program as a way to attract high caliber interdisciplinary students interested in quantitative biology. The departments involved in developing the program are: Physics (Betterton, Glaser), MCDB (Perkins, Dowell, Leinwand), Chem/Biochem (Cech, Knight, Yin, Palmer, Pardi, Nesbitt), Applied Math (Lladser, Bortz), E-Bio (Melbourne), Mechanical Engineering (Ferguson), Chem&Bio Engin (Anseth, Bryant), and Computer Science (Goldberg, Clauset).

Role of Computer Science Faculty in IQ Biology Program Administration: A Steering Committee consisting of at least one representative from each of the participating departments will meet at least once a year to oversee the IQ Biology certificate program. Subgroups of this committee will oversee the recruitment, admissions, and advising of students in the program. Faculty interested in mentoring students will fill out a short application and can be listed as possible rotation opportunities for incoming students.

Number of Students: The IQ Biology program will admit about 6-12 students per year. The Computer Science Department might matriculate 0-2 of these students each year.

Admissions: Admissions will be carried out jointly by the IQ Biology program and the participating departments. Students will apply directly to the IQ Biology program and be first evaluated by the IQ Biology Admissions Committee. Applications that have been approved at this step will be forwarded to the relevant departmental admissions committees. Students will
be encouraged to indicate three departments they would like to apply to; and students must be accepted by at least two departments (or disciplines) to be eventually accepted by the IQ Biology program. IQ Biology will have its own recruitment event, where applicants can be available to meet with departmental faculty as needed. Applications that have successfully been approved by two departments (or disciplines) and the IQ Biology Admissions committee will be officially admitted to a single department. In their first year, accepted students will nominally be enrolled in this department; which department that will be is determined by IQ Biology faculty.

**Course Work:**
Required Graduate Courses for Computer Science Ph.D. students with an IQ Biology Certificate:

*First year*
- IQ Biology Core 1st semester (6 credits), this course has been pre-approved as an out-of-department elective for CS students.
- IQ Biology Core 2nd semester (6 credits): two courses of 3 units each. One of these courses will be cross-listed as a Computer Science course.
- 1-2 other graduate courses to fill gaps in background related to quantitative biology as determined by the IQ Biology Advising Committee

*Second and Third Years*
- 5 Computer Science Breadth Courses with a B+ or better
- 2 other Computer Science Courses at a 5000 level or above
- Scientific Ethics course

For the IQ Biology students, Computer Science will accept that at least 6 of the 30 required credits can be taken outside of the Computer Science Department in the first semester IQ Biology core course. Furthermore, 3 units of the second semester core course is an approved CS cross-listed course.

**Preliminary Exams:** IQ Biology students would take the qualifying exams as defined within Computer Science policy.

**Thesis Proposal/Oral Exam:** The exam will be carried out under Computer Science Policy.

**Dissertation Research:** Dissertation research will be carried out in Computer Science under the direction of a member of the Graduate Faculty. In addition, at least one member of a student’s committee must be an IQ Biology faculty member.

**Dissertation Defense:** The oral defense of a written doctoral dissertation will be carried out in Computer Science as defined within Computer Science policy.

*Original signed MOU available from IQ Biology upon request.*
Re: Memorandum of Understanding

Alterations to Ecology and Evolutionary Biology (EBIO) Ph.D. program to permit inclusion of Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program students

To: Sue Beatty, Ph.D., Assoc. Dean Natural Sciences in the College of Arts and Sciences
Pam Diggle, Ph.D., Chair and Professor of EBIO
David Stock, Ph.D., Assoc. Chair for Graduate Studies, Assoc. Prof. of EBIO

From: Tom Cech, Ph.D., IQ Biology Director, CIMB Director, Prof. of Chem. & Biochem.
Leslie Leinwand, Ph.D., IQ Biology Faculty Member, CIMB CSO, Prof. of MCDB

CC: Jana Watson-Capps, Ph.D., Assistant Director of Interdisciplinary Education, CIMB
Brett Melbourne, Ph.D., IQ Biology Faculty Member, Asst. Prof. of EBIO

Date: 22 December 2010

This memorandum is the enabling document for the inclusion of students from the Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program in the CU-Boulder EBIO Ph.D. program. These students will receive their certificate from the Graduate School and their Ph.D. from the EBIO Ph.D. Program.

The Faculty of the EBIO Department have approved the statement below, which appears in the Department's Graduate Guidelines and in the IQ Biology Graduate Guidelines:

“IQ Biology Certificate Program students will be able to fulfill the EBIO portion of their Ph.D. requirements if the following are completed:

Courses:

IQ Biology
• First semester of IQ Biology Core (6 credits)
• Both second semester IQ Biology Core courses (3 credits each)
• Up to 2 other graduate level quantitative biology courses as determined by the IQ Biology Advising committee
• A scientific ethics course or workshop (i.e., CHEM 5776, 1 credit)

EBIO
• EBIO Colloquium (EBIO 5000, 2 semesters, 1 credit each)
• Introduction to Research (EBIO 6000, 1 credit)
• Approximately 2 to 4 graduate-level courses determined by the student’s committee based on the student’s background.
• Any additional approved graduate-level coursework to add up to 30 credits.
• At least 30 doctoral dissertation hours

All courses must be passed with a B- or higher.
**Qualifying Exam** (i.e., “third semester exam”): Must be taken by the beginning of the student’s 4th semester.

**Comprehensive Exam** (i.e., “fifth semester exam”): Must be taken by end of the student’s 5th semester.

**Teaching Assistantship:** At least two semesters of teaching experience as a 50%-time graduate teaching assistant on the Boulder campus must be completed. Teaching assignments will be determined by the EBIO Graduate Committee. This teaching will not be done in the student’s 1st year, nor is it required in the student’s 2nd year.

**Dissertation Research and Defense:** These will occur as defined within EBIO policy, with the following changes. The formation of a committee and convening the first committee meeting must occur by September of the student’s 2nd year. At least one member of a student’s committee must be an IQ Biology faculty member.

**Explanation of the program:**

**Goal:** EBIO would like to participate in the IQ Biology Certificate program. Some of the students who enter the IQ Biology program will choose to get their Ph.D. degree in EBIO. The addition of an interdisciplinary certificate should not delay a participating student’s graduation by more than one semester.

**Background:**

Addressing multifaceted problems in quantitative biology requires interdisciplinary collaboration. Faculty from eight departments across two schools at CU Boulder have come together to develop a Ph.D. certificate program to train students to use quantitative methods to solve bioscience problems.

Students recruited into the program will be selected based on their capabilities and also their interdisciplinary interests. Each incoming class of students will be chosen to cover a diverse set of disciplines. The students apply directly to the program and potential home departments simultaneously. They work with the other IQ Biology students their first year. Students participate in research rotations in multiple departments and a two-semester core course, in which students work in teams to learn quantitative techniques and their biological applications. In May of their first year, students choose a home department to acquire deep training within a discipline.

Many faculty members from multiple departments are interested in using this program as a way to attract high caliber interdisciplinary students interested in quantitative biology. The departments involved in developing the program are: Physics (Betterton, Glaser), MCDB (Perkins, Dowell, Leinwand), Chem/Biochem (Cech, Knight, Yin, Palmer, Pardi, Nesbitt), Applied Math (Lladser, Bortz), E-Bio (Melbourne), Mechanical Engineering (Ferguson), Chem & Bio Engin (Anseth, Bryant), and Computer Science (Goldberg, Clauset).

**Role of EBIO Faculty in IQ Biology Program Administration:** A Steering Committee consisting of at least one representative from each of the participating departments will meet at least once a year to oversee the IQ Biology certificate program. Subgroups of this committee will oversee the recruitment, admissions, and advising of students in the program. Faculty interested in mentoring students will fill out a short application and can be listed as possible rotation opportunities for incoming students.
**Number of Students:** The IQ Biology program will admit about 6-12 students per year. The EBIO Department might matriculate 0-2 of these students each year.

**Admissions:** Admissions will be carried out jointly by the IQ Biology program and the participating departments. Students will apply directly to the IQ Biology program and be first evaluated by the IQ Biology Admissions Committee. Applications that have been approved at this step will be forwarded to the relevant departmental admissions committees. Students will be encouraged to indicate three departments they would like to apply to; and students must be accepted by at least two departments (or disciplines) to be eventually accepted by the IQ Biology program. IQ Biology will have its own recruitment event, where applicants can be available to meet with departmental faculty as needed. Applications that have successfully been approved by two departments (or disciplines) and the IQ Biology Admissions committee will be officially admitted to a single department. In their first year, accepted students will nominally be enrolled in this department; which department that will be is determined by IQ Biology faculty.

On behalf of our respective entities, we accept these arrangements for IQ Biology certificate program students to also complete the Ph.D. program in EBIO at CU Boulder.

*Original signed MOU available from IQ Biology upon request.*

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Re: Memorandum of Understanding

Alterations to MCDB PhD program to permit inclusion of Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program students

To: Tom Blumenthal, PhD, Chair and Professor of MCDB
    Ken Krauter, PhD, Graduate Committee Chair and Professor of MCDB
    Susan Beatty, PhD, Associate Dean of Natural Sciences, Professor of Geography

From: Tom Cech, PhD, IQ Biology Director, CIMB Director, Prof. of Chem. & Biochem.
      Leslie Leinwand, PhD, IQ Biology Faculty Member, CIMB CSO, Prof. of MCDB
      Tom Perkins, PhD, IQ Biology Faculty Member, Assoc. Prof. of MCDB
      Robin Dowell, D.Sc., IQ Biology Faculty Member, Assist. Prof. of MCDB

CC: Jana Watson-Capps, PhD, Assistant Director of Interdisciplinary Education, CIMB

Date: 23 Nov 2010

This memorandum is the enabling document for the inclusion of students from the Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program in the CU-Boulder MCDB PhD program. These students will receive their certificate in Interdisciplinary Quantitative Biology from the graduate school and their PhD from the MCDB PhD Program.

The Faculty Members of the MCDB Department have approved the statement below, which appears in the Department's Graduate Guidelines and in the IQ Biology Graduate Guidelines:

“IQ Biology Certificate Program students will be able to fulfill the MCDB portion of their PhD requirements if the following are completed:

Courses: Both semesters of IQ Biology Core, up to 2 other graduate level quantitative biology courses as determined by the IQ Biology Advising committee, MCDB 5776, MCDB 5230, MCDB 5210, MCDB 5220, MCDB 5250, and any additional approved coursework to add up to 30 credits. All must be passed with a B- or higher.

Qualifying Exam: To be completed in accord with current PhD. standards in MCDB for all students in a time frame that permits IQ Biology students to complete IQ-specific and MCDB specific course requirements – generally to be finished before the end of the 2nd year.

Comprehensive Exam: To be completed in accord with current PhD standards in MCDB for all students – at the latest before the end of their 3rd year.
**Teaching Assistantship:** Complete requirement as defined within MCDB policy, but not done in the student’s 1st year.

**Dissertation Research and Defense:** These will occur as defined within MCDB policy.

**Explanation of the program:**

**Goal:** MCDB would like to participate in the IQ Biology Certificate program. Some of the students who enter the IQ Biology program will choose to get their PhD degree in MCDB. The addition of an interdisciplinary certificate should not delay a participating student’s graduation by more than one semester.

**Background:**

Addressing multifaceted problems in quantitative biology requires interdisciplinary collaboration. Faculty from eight departments across two schools at CU Boulder have come together to develop a PhD certificate program to train students to use quantitative methods to solve bioscience problems.

Students recruited into the program will be selected based on their capabilities and also their interdisciplinary interests. Each incoming class of students will be chosen to cover a diverse set of disciplines. The students apply directly to the program and potential home departments simultaneously. They work with the other IQ Biology students their first year. Students participate in research rotations in multiple departments and a two-semester core course, in which students work in teams to learn quantitative techniques and their biological applications. At least one rotation must occur in the laboratory of an MCDB faculty member. In May of their first year, students choose a home department to acquire deep training within a discipline.

Many faculty from multiple departments are interested in using this program as a way to attract high caliber interdisciplinary students interested in quantitative biology. The departments involved in developing the program are: Physics (Betterton, Glaser), MCDB (Perkins, Dowell, Leinwand), Chem/Biochem (Cech, Knight, Yin, Palmer, Pardi, Nesbitt), Applied Math (Lladser, Bortz), E-Bio (Melbourne), Mechanical Engineering (Ferguson), Chem&Bio Engin (Anseth, Bryant), and Computer Science (Goldberg, Clauset).

**Role of MCDB Faculty in IQ Biology Program Administration:** A Steering Committee consisting of at least one representative from each of the participating departments will meet at least once a year to oversee the IQ Biology certificate program. Subgroups of this committee will oversee the recruitment, admissions, and advising of students in the program. Faculty interested in mentoring students will fill out a short application and can be listed as possible rotation opportunities for incoming students.

**Number of Students:** The IQ Biology program will admit about 6-12 students per year. The MCDB Department might matriculate 0-3 of these students each year.

**Admissions:** Admissions will be carried out jointly by the IQ Biology program and the participating departments. Students will apply directly to the IQ Biology program and be first evaluated by the IQ Biology Admissions Committee. Applications that have been approved at this step will be forwarded to the relevant departmental admissions committees. Students will be encouraged to indicate three departments they would like to apply to; and students must be accepted by at least two departments (or disciplines) to be eventually accepted by the IQ Biology program. IQ Biology will have its own recruitment event, where applicants can be available to meet with departmental faculty as needed.
Applications that have successfully been approved by two departments (or disciplines) and the IQ Biology Admissions committee will be officially admitted to a single department. In their first year, accepted students will nominally be enrolled in this department; which department that will be is determined by IQ Biology faculty.

**Course Work:**
Required Graduate Courses for MCDB PhD students with an IQ Biology Certificate that must be completed prior to graduation:

*First year*

- IQ Biology Core 1st semester (6 credits)
- IQ Biology Core 2nd semester (6 credits): two courses of 3 units each.
- 1-2 other graduate courses to fill gaps in background related to quantitative biology as determined by the IQ Biology Advising Committee

*Second year*

- Gene Expression (MCDB 5230)
- Scientific Ethics (MCDB 5776)
- Cellular Structure & Function (MCDB 5210)
- Topics in Developmental Genetics: Methods and Logic (MCDB 5250)*
- Molecular Genetics: Methods and Logic (MCDB 5220)*

(*courses may be taken out of traditional order as necessary or waived with approval of IQ Biology and the MCDB Committee on Graduate Student Affairs (COGSA)

For the IQ Biology students, MCDB will accept that at least 12 of the 30 required credits can be taken outside of the MCDB Department in courses appropriate for each student’s research (6 from IQ Biology Core, 6 from gap-filling courses).

**Qualifying Exams:** IQ Biology students would take the qualifying exams as defined within MCDB policy, with the deadline to be decided by COGSA but in no case later than the end of the 2nd year.

**Comprehensive Exams:** IQ Biology students will take these in accordance with MCDB policy and in no case later than the end of their 3rd year.

**Teaching Assistant Requirements:** Students would be required to TA as per MCDB policy, but they would not be required to do it in their first year.

**Dissertation Research:** Dissertation research will be carried out in MCDB under the direction of a member of the Graduate Faculty and supervised by a committee approved by COGSA as is required for all MCDB PhD students.

**Dissertation Defense:** The oral defense of a written doctoral dissertation will be carried out in MCDB as defined within MCDB policy.

On behalf of our respective entities, we accept these arrangements for IQ Biology certificate program students to also complete the PhD program in MCDB at CU Boulder.

*Original signed MOU available from IQ Biology upon request.*

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Re: Memorandum of Understanding

Alterations to Mechanical Engineering PhD program to permit inclusion of Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program students

To: Robert Davis, PhD, Dean of the College of Engineering and Applied Science
    Victor Bright, PhD, Chair and Professor of Mechanical Engineering (ME)
    Shelly Miller, PhD, Chair for Graduate Studies, Assoc. Prof. of ME

From: Virginia Ferguson, PhD, IQ Biology Faculty Member, Assoc. Prof. of ME
      Tom Cech, PhD, IQ Biology Chair, CIMB Director, Prof. of Chemistry & Biochemistry

Date: 1 Nov 2010

This memorandum is the enabling document for the inclusion of students from the Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program in the CU-Boulder Mechanical Engineering PhD program. These students will receive their certificate from the graduate school and their PhD from the Mechanical Engineering PhD Program.

The Faculty of the Mechanical Engineering Department have approved the statement below, which appears in the Department's Graduate Guidelines and in the IQ Biology Graduate Guidelines:

“IQ Biology Certificate Program students will be able to fulfill the Mechanical Engineering portion of their PhD requirements if the following are completed:

Courses: Both semesters of IQ Biology Core (12 credits total), up to 2 other graduate level quantitative biology courses as determined by the IQ Biology Advising committee, scientific ethics course or workshop, ME and IQ biology Seminars, 2 ME math courses (5040 and 5020), 3 other ME Core courses as determined by the advising committee, two ME elective courses and any additional approved coursework to add up to 42 credits. All must be passed with a B- or higher.

Research Preliminary Exams: Deadline postponed till April of student’s 2nd year.

Comprehensive Exam: Will occur after first publication in 3rd or 4th year as defined within Mechanical Engineering Policy.

Dissertation Research and Defense: These will occur as defined within Mechanical Engineering policy.”
Explanation of the program:

Goal: Mechanical Engineering would like to participate in the IQ Biology Certificate program. Some of the students who enter the IQ Biology program will choose to get their PhD degree in Mechanical Engineering. The addition of an interdisciplinary certificate should not delay a participating student’s graduation by more than one semester.

Background:

Addressing multifaceted problems in quantitative biology requires interdisciplinary collaboration. Faculty from eight departments across two schools at UC Boulder have come together to develop a Ph.D. certificate program to train students to use quantitative methods to solve bioscience problems.

Students recruited into the program will be selected based on their capabilities and also their interdisciplinary interests. Each incoming class of students will be chosen to cover a diverse set of disciplines. The students apply directly to the program and potential home departments simultaneously. They work with the other IQ Biology students their first year. Students participate in research rotations in multiple departments and a two-semester core course, in which students work in teams to learn quantitative techniques and their biological applications. In May of their first year, students choose a home department to acquire deep training within a discipline.

Many faculty members from multiple departments are interested in using this program as a way to attract high caliber interdisciplinary students interested in quantitative biology. The departments involved in developing the program are: Physics (Betterton, Glaser), MCDB (Perkins, Dowell, Leinwand), Chem/Biochem (Cech, Knight, Yin, Palmer, Pardi, Nesbitt), Applied Math (Lladser, Bortz), E-Bio (Melbourne), Mechanical Engineering (Ferguson), Chem&Bio Engin (Anseth, Bryant), and Computer Science (Goldberg, Clauset).

Role of Mechanical Engineering Faculty in IQ Biology Program Administration: A Steering Committee consisting of at least one representative from each of the participating departments will meet at least once a year to oversee the IQ Biology certificate program. Subgroups of this committee will oversee the recruitment, admissions, and advising of students in the program. Faculty interested in mentoring students will fill out a short application and can be listed as possible rotation opportunities for incoming students.

Number of Students: The IQ Biology program will admit about 6-12 students per year. The Mechanical Engineering Department might matriculate 0-2 of these students each year.

Admissions: Admissions will be carried out jointly by the IQ Biology program and the participating departments. Students will apply directly to the IQ Biology program and be first evaluated by the IQ Biology Admissions Committee. Applications that have been approved at this step will be forwarded to the relevant departmental admissions committees. Students will be encouraged to indicate three departments they would like to apply to; and students must be accepted by at least two departments (or disciplines) to be eventually accepted by the IQ Biology
program. IQ Biology will have its own recruitment event, where applicants can be available to meet with departmental faculty as needed. Applications that have successfully been approved by two departments (or disciplines) and the IQ Biology Admissions committee will be officially admitted to a single department. In their first year, accepted students will nominally be enrolled in this departments; which department that will be is determined by IQ Biology faculty.

**Course Work:**

Required Graduate Courses for Mechanical Engineering PhD students with an IQ Biology Certificate:

**First Year**
- IQ Biology Core 1st semester (6 credits), pre-approved as out-of-dept electives
- IQ Biology Core 2nd semester (6 credits), pre-approved as out-of-dept electives
- 1-2 other graduate courses to fill gaps in background related to quantitative biology as determined by the IQ Biology Advising Committee, counted as enrichment courses.

**Second and Third Years**
- a scientific ethics course (e.g., CEHN 5838) for 1 credit or a workshop for 0 credits
- ME Graduate Seminar (MCEN 5027)
- 2 ME math courses (MCEN 5020, 5040)
- Pick 3 ME Core courses (e.g., 5021, 5022, 5023)
- Two ME elective courses
- Any additional approved coursework to add up to 42 credits.

For the IQ Biology students, Mechanical Engineering will accept that 15 of the 42 required credits can be taken outside of the Mechanical Engineering Department in courses appropriate for each student’s research and applied to the ME enrichment course requirement. (12 from IQ Biology Core Courses and 3 from gap-filling course).

**Research Preliminary Exams:** IQ Biology students will take these by April of their 2nd year.

**Dissertation Research:** Dissertation research will be carried out in Mechanical Engineering under the direction of a member of the Graduate Faculty. In addition, at least one member of a student’s committee must be an IQ Biology faculty member.

**Dissertation Defense:** The oral defense of a written doctoral dissertation will be carried out in Mechanical Engineering as defined within Mechanical Engineering policy.

On behalf of our respective entities, we accept these arrangements for IQ Biology certificate program students to also complete the PhD program in Mechanical Engineering at CU-Boulder.

*Original signed MOU available from IQ Biology upon request.*

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Department of Physics

Re: Memorandum of Understanding
Alterations to Department of Physics PhD program to permit inclusion of Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program students

To: Paul Beale, Chair, Department of Physics
   Eric Zimmerman, Graduate Chair, Department of Physics

From: Thomas R. Cech, Director, IQ Biology and BioFrontiers Institute and Professor of Chemistry & Biochemistry
       Loren Hough, IQBiology and BioFrontiers Institute Faculty Member and Assistant Professor, Department of Physics
       Meredith Betterton, IQBiology Faculty Member and Associate Professor, Department of Physics

Date: 06 March 2013

This memorandum of understanding (MOU) is the enabling document for the inclusion of students from the Interdisciplinary Quantitative Biology (IQ Biology) Certificate Program in the CU-Boulder Department of Physics PhD program. These students will receive their certificate from the graduate school and their PhD from the Physics PhD program.

The Chair of the Department of Physics has approved the statement below, which appears in the Department's Graduate Guidelines and in the IQ Biology Graduate Guidelines:

IQ Biology Certificate Program students will be able to be admitted to and fulfill the Department of Physics portion of their PhD requirements with the following provisions:

Admission: The physics graduate admissions committee will evaluate students under consideration by the IQ Biology Program with a stated interest in joining the physics department. At the discretion of the physics graduate committee, students can be preapproved for admission to physics, with latitude given to the typical Physics Department admissions requirements. For example, the requirement for the Physics GRE may be waived on a case-by-case basis for otherwise outstanding students. If admitted by the IQ Biology program, students preapproved by the department of physics will have the option to join the physics department as an IQ Biology student at the end of their first year. Some students may be enrolled in the physics department during their first year, while fully supported by the IQ Biology program.
Courses: The coursework requirements are based on the Applied Physics certificate program Ph.D. Curriculum in Biophysics (Quantitative Biology Track). All courses must be passed with a B- or higher. The five core courses that will satisfy the Physics Department Comps I requirement are:

- Physics 5250 Quantum I
- Physics 7310 E&M I
- Physics 7230 Statistical Mechanics I
- Physics 7810 Foundations in Quantitative Biology (6 credits)
- Chem 5776 Scientific Ethics (1 credit seminar course)

Other courses up to 30 credits total will be selected with guidance from the student's Academic Advising from the following list. Normally two of these courses will be IQ Biology second-semester core courses (currently these are MCDB 5550 Cells, Molecules and Tissues: A Biophysical Approach and MCBD 6440 Statistics and Computation for Genomes and Metagenomes), and the majority of electives will be physics classes. Elective course list:

- Physics 5260 Quantum II
- Physics 7320 E&M II
- Physics 7240 Advanced Statistical Mechanics II
- Physics 5160 Lasers
- Physics 5210 Theoretical Mechanics
- Physics 7280 Advanced Quantum Mechanics
- Phys 5606 Optics Laboratory
- Physics 7810 Molecular Simulation (under development by Matt Glaser)
- Physics 7430 Soft Condensed Matter
- MCDB 5550 Cells, Molecules and Tissues: A Biophysical Approach
- MCBD 6440 Statistics and Computation for Genomes and Metagenomes
- MCDB 5210 Cell Structure and Function
- Computer Science 5314 Algorithms for Molecular Biology
- Applied Math 3570 Applied Probability
- Applied Math 5390 or 5720 Mathematical Biology/Modeling
- Chem 5781 Advanced General Biochemistry II (5 credits)
- CHEM 5711 (3). General Biochemistry I
- Chem 5561 Methods in Molecular Biophysics
- Chem 5771 Advanced General Biochemistry I
- Chemical Engineering 5805 Biomaterials
- Chemical Engineering 5836 Nanomaterials

Comprehensive Exam and Dissertation Defense: Will follow the regular Department of Physics guidelines.

Explanation of the program:

Goal: The Department of Physics would like to participate in the IQ Biology Certificate Program. Some of the students who enter the IQ Biology Program will choose to get their PhD degree in Physics. The addition of an interdisciplinary certificate should not delay a participating student's graduation by more than one semester.
Background:

Addressing multifaceted problems in quantitative biology requires interdisciplinary collaboration. Faculty from eight departments across two schools at CU Boulder have come together to develop a PhD certificate program to train students to use quantitative methods to solve bioscience problems.

Students recruited into the program will be selected based on their capabilities and also their interdisciplinary interests. Each incoming class of students will be chosen to cover a diverse set of disciplines. The students apply directly to the program and potential home departments simultaneously. They work with the other IQ Biology students their first year. Students participate in research rotations in multiple departments and a two-semester core course, in which students work in teams to learn quantitative techniques and their biological applications. In May of their first year, students choose a home department to acquire deep training within a discipline.

Many faculty members from multiple departments are interested in using this program as a way to attract high caliber interdisciplinary students interested in quantitative biology. The departments involved in developing the program are: Physics (Betterton, Glaser, Hough), MCDB (Perkins, Dowell, Leinwand), Chem/Biochem (Cech, Knight, Yin, Palmer, Pardi, Nesbitt), Applied Math (Lladser, Bortz), E-Bio (Melbourne), Mechanical Engineering (Ferguson), Chemical and Biological Engineering (Anseth, Bryant), and Computer Science (Goldberg, Clauset).

Role of Physics Faculty in IQ Biology Program Administration: A Steering Committee consisting of at least one representative from each of the participating departments will meet at least once a year to oversee the IQ Biology certificate program. Subgroups of this committee will oversee the recruitment, admissions, and advising of students in the program. Faculty interested in mentoring students will fill out a short application and can be listed as possible rotation opportunities for incoming students.

Number of Students: The IQ Biology Program will admit about 6-12 students per year. The Physics Department might matriculate 0-2 of these students each year.

Admissions: Admissions will be carried out jointly by the IQ Biology Program and the participating departments. Students will apply directly to the IQ Biology Program and first be evaluated by the IQ Biology Admissions Committee. Applications that have been approved at this step will be forwarded to the relevant departmental admissions committees for consideration for preapproval. Students will be encouraged to indicate three departments they would like to apply to, and are typically preapproved in more than one department. Students preapproved by the physics department are conditionally admitted to the physics department graduate program dependent on 1) admission and enrollment in the IQ Biology program 2) satisfactory progress towards their degree and 3) fulfillment of the first year IQ Biology requirements.
If a student, not admitted to IQ Biology, indicates he or she would still like to be considered for admission by a department, those applications will be passed on to the department as part of the standard admissions process. Similarly, preapproved or enrolled students who wish to leave the IQ Biology program at any point and independently join the physics department will not be guaranteed admission and must be reevaluated by the physics department.

IQ Biology will have its own recruitment event, where applicants can be available to meet with departmental faculty as needed. Applications that have successfully been approved by the IQ Biology Admissions Committee will be officially admitted to a single department. In their first year, accepted students will nominally be enrolled in this department, to be determined by IQ Biology faculty.

**Rotations:** IQ Biology students will do three rotations within their first year.

**Teaching Requirements:** Any teaching requirements required of the students will be carried out in accordance with Physics department policy; however, not in the first two years of study while the student receives funding support from the IQ Biology Program.

**Comprehensive Exams:** IQ Biology students will take these as per the Physics Department guidelines.

**Dissertation Research:** Dissertation research will be carried out in the Department of Physics under the direction of a member of the Graduate Faculty. In addition, at least one member of a student’s committee must be an IQ Biology faculty member.

**Dissertation Defense:** The oral defense of a written doctoral dissertation will be carried out in the Physics Department as defined within departmental policy.

On behalf of our respective entities, we accept these arrangements for IQ Biology Certificate Program students to also complete the PhD program in Physics at CU-Boulder

*Original signed MOU available from IQ Biology upon request.*

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Appendix C: Incoming PhD Student Checklist

*Note—this section is adapted from the following Computer Science department Web page (http://www.cs.colorado.edu/grad/newphd/). It somewhat duplicates information found earlier in the graduate handbook, but you may find this presentation of the information useful.

This section provides you, the incoming IQ Biology PhD student, a chronological step-by-step process that will guide you from the day of accepting admission to your first months at the University of Colorado at Boulder. Much of this information is available in the Graduate Student Handbook, which will be referenced often throughout this section.

- After accepting admission
- Two to six months before coming to Boulder
- One month before coming to Boulder
- One to two weeks before classes start
- First week of classes
- First month of school

After Accepting Admission

Get familiar with CU Boulder and IQ Biology!

- Take a look at Information for Incoming Graduate Students. It is a great resource!
- Read the IQ Biology Graduate Student Handbook. This is another great reference that will tell you everything you need to know about this unique program!

Two to Six Months Before Coming to Boulder

During this time, the main focuses on getting to Boulder are housing, keeping track of the mail (electronic and paper) that you receive from University of Colorado, and registering for classes.

- Housing
  - Start looking for housing options. Boulder does have a tight housing market, but there are always open places around campus. And with the great bus system, it's hard to find housing that is not minutes away from a bus stop. Here's a good place to start finding housing options.
  - Find roommates if desired. A good source of potential roommates is the people who attend the visitors’ weekend and then decide to attend the University Colorado at Boulder. Having roommates can help lower living expenses and give you a base of people to know when you arrive in town.

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• **Incoming Mail** *Keep everything. Write down deadlines!*
  - **Health Care Options** There is a deadline for accepting or denying school health care. As graduate students, we get a good discount on the standard plan. See Student Health Insurance for details.
  - **Email Account** Once you get an email account, try it out at CULink Mail and Calendaring to make sure it's set up correctly.
  - **Admissions Form** You do have to pay the deposit. Paying this allows you to get your PIN (Personal Identification Number).
  - **Register for your IdentiKey** You will need your IdentiKey login name and password to login most systems on campus. That login information will come in a CU mailing.
  - **Department Mail** Read over any mail from IQ Biology and your pre-approved department.
  - **Foreign Student Information** This mail will be extremely important for obtaining student visas, seeing deadlines, etc.

• **Contact Advisor**
  - **Remind them you are coming.** Professors are surprisingly busy people and need reminding that they have incoming students. See the Faculty Directory to locate contact information for your advisor. You should have received the name of your first year mentor from the IQ Biology Program by the end of June. If you have not, please contact iqbiology@colorado.edu.
  - **Ask him/her what classes you should take and which lab rotations you should consider.** Your advisor best knows your interests and will give invaluable advice on what classes you should take your first semester.

• **Register for Classes**
  - First semester, **IQ Biology will register for you** (please contact Janice if you have any questions. Afterwards, the following guidelines will apply!)
  - **Do this as early as possible!** Remember to ask your advisor about what classes you should take if possible. If you cannot get a hold of him/her, register for classes anyway. You can always change later.
  - **Use MyCUinfo to register.** Once logged in, registration is under the PLUS tab.

• **Foreign Students**
  - **Visit International Student and Scholar Services.** International Student and Scholar Services has the current up-to-date information needed for your coming to CU Boulder. Read all the information very carefully, looking for due dates and needed paperwork.
One Month Before Coming to Boulder

- **Possibly visit Boulder to secure housing.** If you haven't done so already, see housing options.
- **Get necessary documentation to begin the residency process.**
  - [Car registration, title, and/or lien documents](#) These may take time to retrieve.
  - [Passport or secondary photo ID for driver's license](#) See [Colorado Driver’s License](#) for more information on obtaining a license.
- See the Graduate Student Handbook: Resident Status and Procedures for more information on becoming a Colorado resident.

One to Two Weeks Before Classes Start

- **Move to Boulder.**

- **There will be TA training the week before school starts.** There is a mandatory sexual harassment course that all incoming students must take to work for CU Boulder.

- **Get a Colorado driver's license.** Get the license *before* school starts, as it is a requirement for getting residency for the next school year. While getting your license, make sure you register to vote as well. They should ask you about it when you get your license. You need two forms of ID to get a license (e.g., passport, old license, etc.). Save your receipt as it will make the residency application much easier. See [Colorado Driver's License Locations](#) for licensing locations, phone numbers, and hours.

- **Register your car.** Another aspect of the Colorado state residency application is that you register your car, if you have one, *before* school starts. To register your car, you will need to get an emissions test. Again, save your receipts for the residency application process. See the Boulder County Department of Motor Vehicles for more on registering a vehicle.

- **Get your Buff OneCard.** Our Buff OneCard is simply your student ID card. This card allows you to use the recreation center, among other things. There can be a long line to get the card, so give yourself enough time. See [Buff OneCard](#) for more information on getting and using your Buff OneCard. You can also get your RTD-bus pass in this office.

- **Contact your advisor again.** You'll want to know where you'll be sitting (First year IQ Biology students will always have a spot in room A226 of JSCBB. We will provide you with keys.). During your lab rotations, your advisor may provide you with space in his or her lab and will be able to tell you to which rooms you will need key card access.

- **Buy books.** The CU Book Store should always have the books you need. The Buffalo Chip, housed within the book store, offers software, hardware, accessories and electronic goods, many at educational prices for students, faculty and staff. Online shopping usually saves some money and is worth looking into.

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- **Parking Permits.** Campus parking permit information can be found at Parking and Transportation Services.

- **Foreign Students.** Apply for your social security number as soon as possible. This and related information can be found at International Student and Scholar Services.

*NOTE: The week before school starts will be filled with orientations for both the Program and the University of Colorado. No one has too much trouble getting all the above bullets done, but manage your time well during orientation and make sure you get your driver's license and car registered. These are important first steps in gaining residency, which is necessary to secure full funding in year two!*

### First Week of Classes

- **Set up payroll.** Payroll will be explained to you during orientation, but do this as soon as possible so that you can get paid!

### First Month of School

- **Get a ski pass.** Optional of course, but Colorado does have some of the best skiing in the country. See Colorado Ski Country USA for more about skiing in Colorado.

- **Visit Recreation Center.** Again optional, but you can't work/study all the time! The Rec Center has great facilities and if you pay full student fees (most likely you do!), membership is included in your tuition.

- **Look into transfer credits.** If you have taken previous graduate level classes, you can transfer credits after completing one semester at CU.
Appendix D: Instructions for In-state Tuition Classification Application

Step 1 - Establish Domicile in Colorado by August 23rd, 2016
- Read the instructions for establishing a domicile in Colorado
- Must complete all of these:
  - obtain a Colorado state driver’s license
  - register to vote in Colorado, or not be registered to vote in another state
  - register your vehicle (if you have one) in the state of Colorado
  - file Colorado state income tax (when taxes are normally due in April)

Step 2 – Submit Completed In-state Tuition Classification Petition by June 2017
- READ FIRST: Letter for Petitioners (helpful hints and key information)
- At a minimum, you will need:
  - petition for in-state tuition classification (notarized, can get notarized at the Office of the Registrar in the Regent Administrative Center, room 105) click here for the in-state tuition classification packet
    - evidence of place of residence in Colorado
    - federal and Colorado state income tax returns
    - copy of driver’s license (with voter registration on it)
    - current vehicle registration
- Depending on your situation, you may be required to provide more information.

Step 3 – Visit Office of the Registrar
- If approved for in-state tuition, you must visit the Registrar to verify that you are legally present in the United States.

Questions?
You can contact the Office of the Registrar by phone at 303-492-0907, by email at tuittclass@colorado.edu, or in person at their offices at 105 Regent Administrative Center (9:00am-4:30pm).

Relevant Links
- *Read First* Letter for Petitioners (helpful hints and key information)
- Instructions for establishing a domicile in Colorado
- In-state tuition classification packet
- Check your residency status
- Residency Documentation
- Important Dates
- Office of the Registrar

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Appendix E: Resources and Study Aids

Interdisciplinary Science

- The Bacterial Chromosome: A Physical Biologist’s Apology. A Perspective by Suckjoon Jun

Math

Probability
  - CU Boulder library: No
- Essentials of Stochastic Processes by Richard Durrett
- Simulation, 3rd ed, by Sheldon Ross

Statistics
- Probability and Statistics, by Devore (several editions)
  - Available on campus
- All of Statistics by Larry Wasserman
  - Amazon: http://www.amazon.com/All-Statistics-Statistical-Inference-Springer/dp/0387402721
- The Cartoon Guide to Statistics by Larry Gonick and Wollcott Smith
- Online help:
  - http://stattrek.com/
  - http://davidmlane.com/hyperstat/
- Statistics Done Wrong – The woefully complete Guide
Calculus (single- and multi-variable)

- Calculus, by Hughes-Hallett et al. (Wiley), 5th edition
- Calculus by Michael Spivak
- Introduction to Calculus and Analysis, Volume 1 by Richard Courant and Fritz John
- Online help: (lots of online help available with a simple search)
  - http://www.calculus.org/
  - http://www.math.hmc.edu/calculus/tutorials/

Algebra-based physics

- Physics: Principles with Applications, 6th Ed, D. Giancoli (Pearson, Prentice Hall), Starting with Chapter 16
- Schaum’s Outline of College Physics by Frederick J. Bueche, Eugene Hecht, Paperback: 416 pages, Publisher: McGraw-Hill
  - Amazon: http://www.amazon.com/Schaums-Outline-College-Physics-Frederick/dp/0070089418
- Online Resources:
  - The Physics Hypertextbook: http://physics.info/
  - The Free Physics Textbook: http://www.motionmountain.net/
  - Physics Zone: http://www.sciencejoywagon.com/physicszone/

Biology

Genetics/Genomics

- Concepts of Genetics by Klug, Cummings, Spencer, Palladino
- Genetics: From Genes to Genomes by Hartwell (2010)
- Genetics: Analysis and Principles by Brooker (2011)

- The Cartoon Guide to Genetics by Larry Gonick and Mark Wheelis

- Online Resources
  - Beginning genetics help: [http://learn.genetics.utah.edu/](http://learn.genetics.utah.edu/)
  - University of Houston genetics tutoring links: [http://www.uh.edu/sibs/tutorial/genetics.htm](http://www.uh.edu/sibs/tutorial/genetics.htm)

**Molecular & Cell Biology**


**Online Resources:**


**Biochemistry**


Chemistry

- Principles of General Chemistry, Martin Silberberg, McGraw-Hill, 2nd ed.
  http://www.amazon.com/Martin-Silberberg-Principles-General-Chemistry/dp/B004K3E2GG
- Principles of Chemistry by Munowitz (1999)
- Chemistry: The Central Science by Brown, 10th ed

Online Resources:

- http://www.chemtutor.com/

Organic chemistry

- Loudon "Organic Chemistry" Fifth Edition

- Organic Chemistry by Clayden
- Practical Synthetic Organic Chemistry by Stéphane Caron
  ISBN: 0470037334
  Available at CU

Online resources:

- http://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm

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Computer Science

Algorithms

  Amazon: http://www.amazon.com/Algorithms-Sanjoy-Dasgupta/dp/0073523402
  Link: http://mitpress.mit.edu/algorithms/
- *The Nature of Computation* by Cristopher Moore

Numerical computing

- Numerical Computing with MATLAB by Cleve Moler
  - Link to text online: http://www.mathworks.com/moler/chapters.html
- Numerical methods for scientists and engineers by Richard Hamming
- Numerical Analysis by Timothy Sauer, Pearson Addison-Wesley 2006
- Fundamental Numerical Methods and Data Analysis by George W. Collins, II
  - Online link: http://ads.harvard.edu/books/1990fnmd.book/

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Software engineering

- *Head First Software Development* by Tracey Pilone & Russ Miles
  - Amazon: [http://www.amazon.com/Head-First-Software-Development-Pilone/dp/0596527357](http://www.amazon.com/Head-First-Software-Development-Pilone/dp/0596527357)
- Code Complete by Steve McConnell

Model development


Complex Networks

- *Networks: An Introduction* by Mark Newman
- Algorithms of Large and Complex Networks by Lerner/Wagner/Zweig
  - Online link: [http://www.springerlink.com/content/w175680j5663/#section=188106&page=1](http://www.springerlink.com/content/w175680j5663/#section=188106&page=1)
- Code testing
- Python
- *Learning Python: Powerful Object-Oriented Programming* by Mark Lutz

Matlab

- MATLAB: An Introduction with Applications by Gilat
Appendix F: Rotation Task Abstract Guidelines

Abstract Development Guide and Sample Abstract – submit 1 ½ week prior to presentation.

IN GENERAL: Please use Arial Font size 12 throughout the abstract.

ABSTRACT TITLE: The title should be in bold font. The title should be brief and clearly indicate the nature of the research program. Do not use abbreviations.

AUTHORS: List the names and affiliations of all authors who contributed to this project. As the primary author and presenter your names should be listed first, followed by the names of any students, postdocs, lab staff who facilitated your work. The name of your rotation advisor should be listed last.

ABSTRACT BODY:

2500 character limit. All abstracts MUST include the following:

- Hypothesis statement and why the research is important
- Methods and controls
- Results
- Conclusions and future research questions
- Acknowledgement of funder(s)

*In this case: “This work was supported in part by the Interdisciplinary Quantitative Biology (IQ Biology) program at the BioFrontiers Institute, University of Colorado, Boulder. IQ Biology is generously supported by NSF IGERT grant number 1144807.”

SAMPLE ABSTRACT

Biochemical Characterization, Kinetic Analysis, and Immunolocalization of Rat N-acetyl β-D-glucosaminidase: An Enzyme Required for Mammalian Fertilization

Jane Doe, HRD University, Washington, DC, John Doe HRD University, Washington, DC, Mary Doe, HRD University, Washington, DC

The activity of N-acetyl-β-D-glucosaminidase (EC. 3.2.1. 52) in the mammalian male reproductive tract has been well documented. Of all mammalian tissues surveyed to date, the epididymal organ of the mammalian male reproductive tract exhibits the highest activity of this enzyme. Previous studies have demonstrated that the enzyme is found on the surface of rat sperm cells and facilitates sperm penetration through the zonapellucida (ZP), a carbohydrate-containing cellular matrix that surrounds the egg. The present study was undertaken to isolate and kinetically characterize the enzyme from the testis and various regions of the epididymis, and to immunolocalize the enzyme on the surface of sperm cells using polyclonal
antibodies generated against a purified preparation of the enzyme to test the hypothesis that enzyme remains associated with the sperm surface after ejaculation into the female reproductive tract. The kinetic parameters, Km, Vmax, and Kcat were estimated by Lineweaver-Burk and Direct Linear plots. Indirect immunofluorescence (IIF) studies were used to localize the enzyme on the surface of sperm cells. The Km, Vmax, and Kcat values for the testicular enzyme was 1.33 mM, 4.2 x 10^{-7} mM/min, 2.02 min^{-1}, respectively. In contrast, the Km, Vmax, and Kcat values were significantly different for the epididymal enzyme. For example, the Km, Vmax, and Kcat values for the enzyme associated with the caudal region of the epididymis were 0.52 mM, 5.0 x 10^{-6} mM/min, and 973 min^{-1}, respectively. IIF labeling revealed that the enzyme is redistributed primarily over the head region of sperm cells as they mature in the epididymis and demonstrated that the enzyme remains associated on the head region of sperm cells up to six hours after ejaculation and being deposited into the female reproductive tract. These data indicate that the enzyme becomes more active and migrates to the head region as sperm cells mature in the epididymis and provides evidence to support the hypothesis that the enzyme remains associated with the sperm cell even after being deposited in the female reproductive tract [This work was supported in part by the Interdisciplinary Quantitative Biology (IQ Biology) program at the BioFrontiers Institute, University of Colorado, Boulder. IQ Biology is generously supported by NSF IGERT grant number 1144807.]