



# **Computational Biology & Bioinformatics at Yale**

*An Interdepartmental PhD Program  
and a Track within  
Yale's Combined Program in the  
Biological and Biomedical Sciences*

**2018-2019**

## Table of Contents

Introduction .....	3
Participating Faculty .....	4
CBB Graduate Program Administration .....	7
CBB Students .....	8
Noteworthy Numbers and Addresses .....	10
Requirements/Curriculum Overview .....	12
Optional Focus on Translational Informatics .....	15
Optional Focus on Biomedical Data Science .....	15
Rotations .....	17
Teaching Assistantships .....	18
Qualifying Exam/Admission to Candidacy/Dissertation .....	18
Dissertation Committee/Dissertation Procedures .....	20
MS Degree (en route to PhD) .....	21
Career Planning .....	21
CBB Events .....	22
Financial Support .....	23
Health Coverage .....	23
Housing .....	24
Graduate Writing Center .....	25

Applications to the CBB track are located on the Yale BBS site at  
<https://medicine.yale.edu/bbs/apply/>

## Introduction

Computational Biology and Bioinformatics (CBB) is a rapidly developing multi-disciplinary field. The systematic acquisition of data made possible by genomics and proteomics technologies has created a tremendous gap between available data and their biological interpretation. Given the rate of data generation, it is well recognized that this gap will not be closed with direct individual experimentation. Computational and theoretical approaches to understanding biological systems provide an essential vehicle to help close this gap. These activities include computational modeling of biological processes, computational management of large-scale projects, database development and data-mining, algorithm development and high-performance computing, as well as statistical and mathematical analyses.

Yale has an interdepartmental CBB PhD program. The advantage of an interdepartmental program is that CBB students complete the CBB curriculum (described later in this booklet), and then can do their dissertation research in the laboratory of a faculty member at Yale in any relevant department at Yale, which might be a biological science department, computer science, statistics, applied math, etc. (They do not have to satisfy the PhD requirements of their research advisor's department.)

To enter the PhD program, students apply to the CBB track within Yale's combined program in the Biological and Biomedical Sciences (BBS): <http://bbs.yale.edu/apply/index.aspx>

We welcome your interest in Yale's CBB program.

Mark Gerstein, PhD  
Hongyu Zhao, PhD  
Co-Directors, Interdepartmental CBB PhD Program  
Co-Directors, CBB Track within Yale's BBS Program

## Computational Biology and Bioinformatics Participating Faculty

(For additional information: <http://cbb.yale.edu/faculty-labs>)

Julien Berro <a href="mailto:julien.berro@yale.edu">julien.berro@yale.edu</a>	Assistant Professor	MB&B	B-24 West Campus 203-737-3285
Marcus Bosenberg <a href="mailto:marcus.bosengberg@yale.edu">marcus.bosengberg@yale.edu</a>	Professor	Dermatology	789 Howard Avenue 203-737-3484
Cynthia Brandt <a href="mailto:cynthia.brandt@yale.edu">cynthia.brandt@yale.edu</a>	Professor	Emergency Medicine	464 Congress Avenue 203-737-5762
Joseph Chang <a href="mailto:joseph.chang@yale.edu">joseph.chang@yale.edu</a>	Professor	Statistics	24 Hillhouse Avenue 203-432-0642
Kei-Hoi Cheung <a href="mailto:kei.cheung@yale.edu">kei.cheung@yale.edu</a>	Professor	Emergency Medicine	464 Congress Ave 203-737-5783
Ronald Coifman <a href="mailto:coifman-ronald@yale.edu">coifman-ronald@yale.edu</a>	Professor	Mathematics Computer Science	AKW 108A 203-432-1213
Chris Cotsapas <a href="mailto:chris.cotsapas@yale.edu">chris.cotsapas@yale.edu</a>	Associate Professor	Neurology Genetics	300 George St, RM353H 203-737-2896
Forrest Crawford <a href="mailto:forrest.crawford@yale.edu">forrest.crawford@yale.edu</a>	Assistant Professor	Biostatistics	LEPH 207 203-785-6125
Stephen Dellaporta <a href="mailto:stephen.dellaporta@yale.edu">stephen.dellaporta@yale.edu</a>	Professor	MCDB	165 Prospect Street 203-432-3895
Richard Flavell <a href="mailto:richard.flavell@yale.edu">richard.flavell@yale.edu</a>	Professor	Immunobiology	TAC S569A 203-737-2216
Joel Gelernter <a href="mailto:joel.gelernter@yale.edu">joel.gelernter@yale.edu</a>	Professor	Genetics	950 Campbell Avenue 203-932-5711
Mark Gerstein <a href="mailto:mark.gerstein@yale.edu">mark.gerstein@yale.edu</a>	Co-Director CBB Professor	MB&B Computer Science	BASS 432A 203-432-6105
Antonio Giraldez <a href="mailto:antonio.giraldez@yale.edu">antonio.giraldez@yale.edu</a>	Professor	Genetics	SHM I-142B 203-785-5423
Murat Gunel <a href="mailto:murat.gunel@yale.edu">murat.gunel@yale.edu</a>	Professor	Neurosurgery Neurobiology Genetics	TMP 4 203-737-2096

Monika Jadi <a href="mailto:monika.jadi@yale.edu">monika.jadi@yale.edu</a>	Assistant Professor	Neuroscience	300 George Street 310-866-0870
Amy Justice <a href="mailto:amy.justice@yale.edu">amy.justice@yale.edu</a>	Professor	Public Health	950 Campbell Avenue 203-932-5711
Naftali Kaminski <a href="mailto:naftali.kaminski@yale.edu">naftali.kaminski@yale.edu</a>	Professor	Medicine	300 Cedar Street
Douglas Kankel <a href="mailto:douglas.kankel@yale.edu">douglas.kankel@yale.edu</a>	Professor	MCDB	KBT 1118A 203-432-3532
Steven Kleinstein <a href="mailto:steven.kleinstein@yale.edu">steven.kleinstein@yale.edu</a>	Associate Professor	Pathology	300 George St, Ste 505 203-785-6685
Yuval Kluger <a href="mailto:yuval.kluger@yale.edu">yuval.kluger@yale.edu</a>	Associate Professor	Pathology	300 George St, Ste 505 203-737-6262
Smita Krishnaswamy <a href="mailto:smita.krishnaswamy@yale.edu">smita.krishnaswamy@yale.edu</a>	Assistant Professor	Genetics	333 Cedar St 203-785-7833
Harlan Krumholz <a href="mailto:harlan.krumholz@yale.edu">harlan.krumholz@yale.edu</a>	Professor	Medicine	1 Church Street 203-764-5888
Bluma Lesch <a href="mailto:bluma.lesch@yale.edu">bluma.lesch@yale.edu</a>	Assistant Professor	Genetics	333 Cedar Street 203-737-1074
Morgan Levine <a href="mailto:morgan.levine@yale.edu">morgan.levine@yale.edu</a>	Assistant Professor	Pathology	300 George Street 203-432-3650
Haifan Lin <a href="mailto:haifan.lin@yale.edu">haifan.lin@yale.edu</a>	Professor	Cell Biology Genetics	AMISB Rm 237 203-785-6215
Jun Lu <a href="mailto:jun.lu@yale.edu">jun.lu@yale.edu</a>	Associate Professor	Genetics	AMISB 237C 203-737-3426
Shuangge Ma <a href="mailto:shuangge.ma@yale.edu">shuangge.ma@yale.edu</a>	Associate Professor	EPH	LEPH 206 203-785-3119
Benjamin Machta <a href="mailto:benjamin.machta@yale.edu">benjamin.machta@yale.edu</a>	Assistant Professor	Physics	217 Prospect Street 203-432-3650
Kathryn Miller-Jensen <a href="mailto:kathryn.miller-jensen@yale.edu">kathryn.miller-jensen@yale.edu</a>	Associate Professor	Engineering	55 Prospect Street 203-432-4265
James Noonan <a href="mailto:james.noonan@yale.edu">james.noonan@yale.edu</a>	Associate Professor	Genetics	SHM I-142C 203-737-1922

Corey O'Hern <a href="mailto:corey.ohern@yale.edu">corey.ohern@yale.edu</a>	Associate Professor	Mech. Engineering Physics	ML 203 203-432-4258
Lajos Pusztai <a href="mailto:lajos.pusztai@yale.edu">lajos.pusztai@yale.edu</a>	Professor	Oncology	300 George Street 203-737-8309
Anna Marie Pyle <a href="mailto:anna.pyle@yale.edu">anna.pyle@yale.edu</a>	Professor	MCDB	BASS 334A 203-432-5633
Gordon Shepherd <a href="mailto:gordon.shepherd@yale.edu">gordon.shepherd@yale.edu</a>	Professor	Neuroscience	FMB 236 207-85-4336
David Stern <a href="mailto:df.stern@yale.edu">df.stern@yale.edu</a>	Professor	Pathology	310 Cedar Street 203-785-4832
Jeffrey Townsend <a href="mailto:jeffrey.townsend@yale.edu">jeffrey.townsend@yale.edu</a>	Associate Professor	EPH (Biostatistics) EEB	135 College St. 203-737-7042
Gunter Wagner <a href="mailto:gunter.wagner@yale.edu">gunter.wagner@yale.edu</a>	Professor	Ecology/Evolutionary Biology	B31 West Campus 203-432-9998
Anita (Zuoheng) Wang <a href="mailto:zuoheng.wang@yale.edu">zuoheng.wang@yale.edu</a>	Associate Professor	EPH (Biostatistics)	LEPH 200 203-737-2672
Heping Zhang <a href="mailto:heping.zhang@yale.edu">heping.zhang@yale.edu</a>	Professor	EPH Statistics	LEPH 202 203-785-5185
Hongyu Zhao <a href="mailto:hongyu.zhao@yale.edu">hongyu.zhao@yale.edu</a>	Co-Director CBB Professor	EPH Statistics	300 George St, Ste 503 203-785-3613
Steven Zucker <a href="mailto:steven.zucker@yale.edu">steven.zucker@yale.edu</a>	Professor	Computer Science Electrical Eng	AKW 407 203-432-6434

## **CBB Graduate Program Administration**

Co-Directors of Graduate Studies

Hongyu Zhao 300 George Street, Suite 503 203-785-3613

Mark Gerstein BASS 432A 203-432-6105

The Directors of Graduate Studies (DGS) are responsible for the overall operation of the graduate program. They monitor student progress through the program, approve course schedules, and coordinate qualifying exams. If you have any concerns regarding your academic progress, registration status, a faculty member or advisor, the DGS is one to approach.

Graduate Program Registrar

Lisa Sobel 300 George Street 203-737-6029  
Suite 501

The Graduate School Registrar keeps the graduate student files. She enters graduate student payroll, provides administrative support to the students, the Directors of Graduate Studies, and the Admissions Committee. She handles curriculum, department fellowship information, student forms, and academic schedules and room reservations.

## **CBB Graduate Students**

<u>CBB Graduate Students</u>	<u>Advisor</u>	<u>Location</u>
David Chang	Hongyu Zhao Cynthia Brandt	300 George St, Ste 503 300 George St, YCMI
Evan Cudone	Monkol Lek	300 Cedar Street
Jeffrey Fisk	Jeffrey Townsend	135 College Street
Jiahao Gao	Mark Gerstein	BASS
Scott Gigante	Smita Krishnaswamy Ronald Coifman	51 Prospect Street
Mengting Gu	Mark Gerstein	BASS
Dingjue Ji	Hongyu Zhao	300 George St, Ste 503
Pranav Kantroo	Gunter Wagner Benjamin Machta	840 West Campus Drive 217 Prospect Street
Michael Klein	Hongyu Zhao David Stern	300 George St, Ste 503 310 Cedar St
Donghoon Lee	Mark Gerstein	BASS
Tianxiao Li	Mark Gerstein	BASS
Xiaotong Li	Mark Gerstein Lajos Pusztai	BASS 300 George St, Ste 120
Wei Liu	Hongyu Zhao	300 George St, Suite 503
Kevin Lopez	Cynthia Brandt	300 George St, YCMI
Hussein Mohsen	Mark Gerstein	BASS
Nir Neumark	Ronald Coifman Naftali Kaminski	1 Church Street 300 Cedar Street
Ryan Powles	Hongyu Zhao Lajos Pusztai	300 George St, Ste 503 300 George St, Ste 120
Rihao Qu	Yuval Kluger Richard Flavell	300 George St, Ste 505 300 Cedar St



Alexandra Signoriello	Corey O'Hern Marcus Bosenberg	ML 203
Ruijie Song	Murat Acar	300 Heffernan Dr
Jay Stanley	Smita Krishnaswamy	51 Prospect Avenue
Jiawei Wang	Hongyu Zhao	300 George St, Ste 503
Yixuan Ye	Hongyu Zhao	300 George St, Ste 503
Zhaolong Yu	Hongyu Zhao	300 George St, Ste 503
Jun Zhao	Yuval Kluger Richard Flavell	300 George St, Ste 505 TAC S569A
Geyu Zhou	Hongyu Zhao	300 George St, Ste 503
Quan Zhou	Steven Kleinstein	300 George St, Ste 505

## Noteworthy Numbers & Addresses

**BBS Program** Director – Anthony Koleske  
SHM CE31  
203-785-5624

Administrative Director – John Alvaro [john.alvaro@yale.edu](mailto:john.alvaro@yale.edu)  
37-55 College Street  
203-785-3735

### **Graduate School Student Issues**

Richard Sleight [richard.sleight@yale.edu](mailto:richard.sleight@yale.edu)  
Warner House, 1 Hillhouse Avenue  
203-432-2744

### **Assistant Dean**

Robert Harper-Mangels [robert.harper-mangels@yale.edu](mailto:robert.harper-mangels@yale.edu)  
Warner House, 1 Hillhouse Avenue  
203-432-2744

### **Registrar**

Gabriel Olszewski [gabriel.olszewski@yale.edu](mailto:gabriel.olszewski@yale.edu)  
246 Church Street  
203-432-4461

Mr Olszewski handles course schedule and changes, dissertation progress reports, grades, leave of absence, petitions for degrees, petitions for extended registration, registration forms, address and name changes.

### **Financial Aid Office**

Director Sara Estrom  
1 Hillhouse Avenue  
203-432-7980

Assistant Director Susan Wrzosek  
1 Hillhouse Avenue  
203-432-2899

The office handles paychecks, address changes, and loan applications.

### **McDougal Graduate Student Center**

Assistant Dean of Student Life Lisa Brandes  
HGS 126  
203-432-8895

### **Office of Diversity and Equal Opportunity**

Associate Dean and Director Michelle Nearon  
Warner House, 1 Hillhouse Avenue  
203-436-1301

**Graduate Admissions Office**

Director Leah Phinney  
Warner House, 1 Hillhouse Avenue  
203-432-6814

This office handles questions related to admission or readmission to the Graduate School.

Other University Offices

Student Financial and Administrative Services (SFAS)

Bursar's Office  
246 Church Street  
203-432-2700

International Students & Scholars Office

421 Temple Street  
203-432-2305

International Center

421 Temple Street  
203-432-2305

Night Student Security

Transit Service  
203-432-6330

University Police

101 Ashmun Street  
203-432-4400 (dispatch)

Yale Visitor Center

149 Elm Street  
203-432-2300

Yale University Health Service/Yale Health Plan

55 Lock Street  
Urgent Care (24/7) 203-432-0123  
Student Health 203-432-0312  
General Information 203-432-0246

## Requirements/Curriculum Overview

### Admissions Requirements

Applicants are expected 1) to have a strong foundation in the basic sciences, such as biology, chemistry and mathematics, and 2) to have training in computing/informatics, including significant computer programming experience. The Graduate Record Examination (GRE) General Test is required, and the GRE Subject Test in cell & molecular biology, biology, biochemistry, chemistry, computer science, or other relevant discipline is recommended. Alternatively, the Medical College Admission Test (MCAT) may be substituted for the GRE tests. Applicants for whom English is not their native language are required to submit results from the Test of English as a Foreign Language (TOEFL).

### Requirements for the PhD degree

This section outlines the current CBB curriculum, and other requirements for the PhD degree. Because of the interdisciplinary nature of the field, we anticipate that the students will be extremely heterogeneous in their background and training. As a result, a welcoming/advisory committee will help students individually tailor the curriculum to their background and interests. The emphasis will be on gaining competency in three broad "core areas":

- computational biology and bioinformatics
- biological sciences
- informatics (including computer science, statistics, and applied mathematics)

Completion of the curriculum will typically take 4 semesters, depending in part on the prior training of the student. Since students may have very different prior training in biology and computing, the courses taken may vary considerably. In addition, students will spend a significant amount of time during this period doing intensive research rotations in faculty laboratories and attending relevant lectures and seminars.

Specifically, we expect that all students will:

- take at least ten (10) courses as follows:
  - three (3) required graduate courses in computational biology and bioinformatics,
  - two (2) graduate courses in the biological sciences,
  - two (2) graduate courses in areas of informatics,
  - two (2) additional courses in any of the three core areas (which may be undergraduate courses taken to satisfy areas of minimum expected competency, as described below),
  - one (1) year-long graduate course that consists of three lab rotations taken over the fall and spring semesters of the first year (graded as pass or fail),
  - any additional courses required to satisfy areas of minimum expected competency,

- take a half-semester graduate seminar on research ethics in the 1st and 4<sup>th</sup> years (graded as credit or non-credit),
- attend a CBB seminar series,
- serve as a teaching assistant in two semester courses.

Students will typically take 2-3 courses each semester and 3 research rotations during the first year. Students are expected to find a dissertation advisor (or co-advisors) by the end of the first year. In the summer after the first year, students will start working in the laboratory of their chosen PhD thesis supervisor. Students must pass a qualifying examination normally given at the end of the second year or the beginning of the third year. There is no language requirement.

In addition to the curriculum outlined above, the program has also defined an initial set of guidelines for minimum expected competency in biology, computer science, statistics, and mathematics. Some students may have satisfied all of these areas prior to entering our program. Other students may need to take undergraduate or graduate courses at Yale to satisfy one or more of these specific areas. These guidelines are in evolution and may be refined over time as we get more experience with the program.

Students may be able to waive some course requirements based on graduate coursework completed at other universities where they have been enrolled as a graduate student. Courses must be equivalent to Yale graduate courses, and the Graduate School usually sets a maximum limit of three courses that can be waived.

### **Courses in Computational Biology and Bioinformatics**

CBB students are required to take the 3 CBB core courses CBB 752, CBB 740 or CBB 561, and CBB 750 or CBB 562 and the year-long sequence of lab rotations 711, 712, 713.

CBB 523a Biological Physics (not given in 2017-2018)  
 CBB 555a Machine Learning for Biology  
 CBB 562b Dynamical Systems in Biology  
 CBB 645b Statistical Methods in Genetics and Bioinformatics (not given in 2017-2018)  
 CBB 647b Statistical Methods in Human Genetics  
 CBB 740a Clinical and Translational Informatics  
 CBB 745b Advanced Topics in Machine Learning and Data Mining  
 CBB 750b Core Topics in Biomedical Informatics  
 CBB 752b Biomedical Data Science: Mining and Modeling  
 CBB 711 1<sup>st</sup> Lab Rotation  
 CBB 712 2<sup>nd</sup> Lab Rotation  
 CBB 713 3<sup>rd</sup> Lab Rotation

### **Courses in Biological Sciences**

Courses are available in many departments, including Molecular, Cellular, and Developmental Biology, Ecology and Evolutionary Biology, Molecular Biophysics and Biochemistry, Genetics, Cell Biology, Physics and Engineering and Applied Science.

Courses that CBB graduate students have taken in recent years include the following. (Not all courses are offered every year.)

CBIO 602a Molecular Cell Biology  
EEB 525b Evolutionary Biology (not given in 2016-17)  
ENAS 517b Methods and Logic in Interdisciplinary Research  
ENAS 991b Integrated Workshop (not given in 2016-17)  
GENE 625a Basic Concepts: Genetics Analysis  
GENE 777b Mechanisms of Development  
IBIO 530a Biology of Immune System  
MBB 523a Biological Physics  
MBB 600a Principles of Biochemistry I  
MBB 602a Molecular Cell Biology  
MBB 743b Advanced Eukaryotic Molecular Biology  
MCDB 570b Biotechnology  
PATH 650b Cellular and Molecular Biology of Cancer  
PATH 690a Molecular Mechanisms of Disease  
PHYS 523a Biological Physics

### **Informatics Courses**

#### Computer Science and Related Courses

Courses are available in Computer Science and other departments. Example courses that CBB graduate students might take include the following:

CPSC 524b Parallel Programming Techniques  
CPSC 537a Introduction to Database Systems  
CPSC 545a Introduction to Data Mining  
CPSC 570a Artificial Intelligence

#### Statistics Courses

Many CBB students have taken the following statistics courses:

S&DS 538a Probability and Statistics  
S&DS 645b Statistical Methods in Computational Biology  
S&DS 563b Multivariate Statistical Methods for the Social Sciences

CBB students have also enrolled in the following statistics courses:

S&DS 530b Data Exploration and Analysis  
S&DS 541a Probability Theory  
S&DS 542b Theory of Statistics  
S&DS 551b Stochastic Processes  
S&DS 610a Statistical Inference  
S&DS 612a Linear Models  
S&DS 661b Data Analysis  
S&DS 665b Applied Data Mining and Machine Learning

## **Research Ethics Course**

CBB 601b Responsible Conduct of Research

## **Optional Focus on Translational Informatics**

CBB graduate students (PhD or MS) may elect to pursue an optional focus on "Translational Informatics." Translational research is concerned with bringing bioscience research discoveries into patient care. The CBB Translational Informatics focus emphasizes the intersection of bioinformatics and disease, and includes topics from both bioinformatics and clinical informatics. Examples include 1) research that uses genomic technologies to help better understand the mechanisms of disease, 2) organizing data from the electronic medical record to help define the clinical phenotype of many diseases, 3) building informatics tools that analyze clinical and bioscience data in an integrated fashion, and 4) the computer modeling of disease processes. A CBB student may select this focus area at any time. The overall CBB curriculum is unchanged, but Translational Informatics requires that at least two of the courses taken must have a major focus on clinical medicine and/or disease. There are many such courses. Examples include:

- GENE 500b Principles of Human Genetics (not given in 2016-17)
- CBIO 601a/b Molecular and Cellular Basis of Human Disease
- IBIO 530a Biology of the Immune System
- INP 507b Cellular and Molecular Mechanisms of Neurological Disease
- PATH 650b Cellular & Molecular Biology of Cancer
- BIS 540a Fundamentals of Clinical Trials (not given in 2015-16)

The PhD dissertation or MS degree project must focus on a topic related to Translational Informatics.

## **Optional Focus on Biomedical Data Science**

CBB graduate students (PhD or MS) may elect to pursue an optional focus on "Biomedical Data Science." The track exposes students to data science training and educational initiatives at Yale. The track's initial direction is Big Data analytics of large medical claims and clinical datasets. Students may opt to participate in research opportunities within the Yale Center for Outcomes Research and Evaluation (CORE, Prof. Krumholz, director). CORE maintains its dedicated BD2K division, which includes many of the core training grant faculty (Profs. Zhao, Gerstein, Zhou). Students have access to a myriad of data sets, dedicated and secured server infrastructure, program management staff assisting in data familiarization, and may attend a BD2K seminar. CORE is one of many ongoing data science initiatives at Yale, which also includes the VA's PRIME COIN (Profs. Brandt, Justice), the Yale Institute for Network Sciences (Prof. Gerstein), and emerging data science initiatives at the future Department for Statistics and Data Science (currently Department of Statistics, Prof. Zhou).

At least four other courses taken must have a major focus on biomedical data sciences. There

are many such courses. Examples include:

- MATH 244a Discrete Mathematics
- MATH 246a Ordinary Differential Equations
- MATH 541 Probability Theory
- STAT 530 Introductory Data Analysis
- STAT 538 Probability and Statistics
- STAT 542 Theory of Statistics
- STAT 551 Stochastic Processes
- STAT 660 Multivariate Statistical Methods
- STAT 610 Statistical Inference
- STAT 612 Linear Models
- STAT 661 Data Analysis
- STAT 665 Data Mining and Machine Learning
- CPSC 365b Algorithms
- CPSC 462 Graphs and Networks
- CPSC 540b Numerical Computation



## Rotations

All students are required to take at least three rotations. This can be supplemented with a fourth rotation in the summer after the second semester, if the student has not yet found a dissertation advisor. Three credits will be given for the 3 rotation sequence, which is graded as pass/fail.

Rotation schedule for 2018 -2019 (approximate):

Late September – November 16

November 26 – March 8

March 25 – May 17

The laboratory rotations provide students with the opportunity to broaden their scientific experience in Computational Biology and Bioinformatics and are the basis for ultimately choosing the laboratory for their thesis research. The CBB Registrar maintains a notebook with short reports about all the rotations that CBB students have done in the past. Entering students are encouraged to consult this resource.

Students should take time early on to acquaint themselves with the science that is being conducted in the labs of the CBB faculty. For example:

- Visits to group meetings are encouraged. Schedules for group meetings are generally listed on the faculty websites (<http://cbb.yale.edu/faculty.html> has links). After reviewing the work being conducted in the lab of your interest, make an appointment to speak with the P.I. and have ready an idea of the type of work you are interested in.
- Several BBS departments schedule retreats during the fall to acquaint BBS students with the research being performed by their faculty. All first year BBS students are invited.
- The CBB program schedules sessions where certain CBB faculty describe their research interests.

### **What happens during rotations?**

Students are expected to devote non-classroom time to the rotation. This works out to approximately 15-20 hours per week. You will be given space and are expected to join in discussions with the group. Your project should be discussed with the PI or a senior member of the lab at the beginning of the rotation. Although completing a well-defined project may be possible, the short rotation period may not allow this. The most important aspect of the rotation is familiarizing yourself with the work of the lab and participating in meetings, discussions, and seminars. This is the basis on which you and a faculty member will decide on whether you would be a good fit for the lab.

Both student and PI are required to submit evaluations at the end of the rotation. Forms will be sent by the registrar. It is expected that the forms will be returned within a two week period.

## Teaching Assistantships

All CBB PhD students are required to serve as teaching assistants in two semester-long courses during their training period. Appointments as a teaching assistant count for a portion of the normal stipend for the appropriate term. Teaching provides the student the opportunity to develop teaching skills under the guidance of faculty. Attendance at all classes and discussion sessions is essential. On average, TAs should expect to spend about 10 hours per week on teaching and grading class assignments. TAs and faculty should remain clear on what is expected of their assignment. TAs are normally expected to grade exams. It is imperative that TAs remain aware of exam deadlines and make arrangements with faculty in case there should be any conflicts.

As an interdepartmental program, CBB allows teaching assistantships in a wide variety of courses. The CBB Registrar maintains a list of all the courses in which CBB students have been TAs. This is a useful starting point for finding a TA. In June each year, a list of available TA opportunities in the fall and spring semesters within the BBS departments is emailed to all CBB students. Students who wish to teach in the following academic year should fill out the form indicating which courses they would like to TA in and return the form to the CBB Registrar, Lisa Sobel. She, in turn, forwards each student's request to the registrar of the appropriate department, where the TA selection is made. The forms should be returned as soon as possible as class requests fill up quickly. Students should consider contacting faculty well in advance of the selection notice to convey their interest in assisting in specific courses.

If students are interested in teaching outside BBS, e.g., Computer Science, Bioengineering, Statistics, etc., they should contact the registrar within each program. Email the CBB Registrar ([lisa.sobel@yale.edu](mailto:lisa.sobel@yale.edu)) for a listing of contacts.

## Qualifying Exam/Admission to Candidacy/Dissertation

As early as the fourth semester and no later than the sixth semester, the student undertakes a series of activities that lead to admission to candidacy for the PhD degree, with the major milestones being the selection of a Qualifying Exam Committee, passing of the Qualifying Exam and selection of a Dissertation Committee. As part of the Qualifying Exam, the student presents a dissertation prospectus, which must be approved by the Qualifying Exam Committee. The Qualifying Exam must be successfully completed before the beginning of the seventh semester. Following admission to candidacy, the student selects a Dissertation Committee, which may have the same members as the Qualifying Committee. The Advisor must be a member of this committee. The Dissertation Committee's role is to guide the student towards the PhD degree and to approve the thesis.

1. In the fourth or fifth semester, the student should select a Qualifying Exam (QE) Committee. The QE Committee may have 3 or 4 members. The Advisor may be a member of the QE Committee, but does not need to be. The composition of the QE Committee must be approved by the Advisor and the CBB Director of Graduate Studies (DGS).
2. The Advisor designates a Chair of the QE Committee. This may be the Advisor, but does

not need to be.

3. The student then notifies the CBB Graduate Registrar of the members and chair of the QE Committee.
4. The QE process requires two meetings of the QE Committee, a “Pre-Qualifying Exam” meeting and the actual Qualifying Exam. The QE may be completed before all required CBB program coursework has been taken and before the two Teaching Assistantships.
  - a. For the pre-qualifying exam meeting, the student prepares a 2-3 page double-spaced preliminary research proposal and distributes it to Committee members before the meeting. The student meets with the Qualifying Exam Committee to present and discuss that proposal. The Committee then decides whether the student is ready to prepare for the QE exam itself. If so, the Committee identifies 3 or 4 topic areas on which the student will be questioned during the oral qualifying exam. These topics are typically chosen to represent a mix of biological and computational areas. The QE Committee completes an evaluation form at the end of this meeting, identifying any concerns and recommendations for the student, and listing the topics on which the student will be questioned at the actual Qualifying Exam.
  - b. For the second QE meeting, the student prepares a 15-20 page double-spaced dissertation prospectus in the form of a research proposal, which should contain: 1) a specific question or questions that will be addressed, 2) a brief literature review indicating the present state of the field of intended research, 3) an overview of preliminary work that the student has performed to date, and 4) a research plan outlining work to be undertaken in the future. The prospectus should ideally be distributed to the committee two weeks before the second QE meeting. During the QE, the student presents and discusses the prospectus (usually in the form of a brief PowerPoint presentation) and is questioned on it and on the several topic areas previously identified by the Committee. The QE Committee completes an evaluation form at the end of this meeting, listing any concerns and recommendations for the student.
  - c. Participation of the Advisor in the Qualifying Exam is desirable but not required.
4. The basic purpose of the Qualifying Exam is to assure that the student is well prepared to pursue significant dissertation research. The possible outcomes of the Qualifying Exam include Pass with Distinction, Pass, Conditional Pass, and Fail. At the end of the second QE meeting, the QE Committee may put in writing a specific set of conditions and a timeframe in which these conditions must be fulfilled, in order for the student to pass the Qualifying Exam.
5. The Chair of the QE Committee informs the CBB DGS and Registrar of the results of the QE. Once the student has passed the QE, the CBB program recommends to the Graduate School that the student be admitted to candidacy for the PhD. A copy of the Dissertation prospectus is sent to the Graduate School. The student must also have fulfilled the Graduate School’s requirement of two Honors grades in classes taken at Yale. The student need not have completed all coursework, fulfilled all TA requirements, nor, if relevant, passed the Speak Test in order to be admitted to candidacy.

## Dissertation Committee/Dissertation Procedures

1. After the student has passed the Qualifying Exam and been admitted to candidacy, the QE Committee transitions to the Dissertation Committee. Subject to the approval of the Advisor and the CBB DGS, the membership of the Dissertation Committee may be changed from the QE Committee. The Advisor must be a member of the Dissertation Committee. The Dissertation Committee and CBB DGS are responsible for ensuring that student's PhD research is within the broad field of computational biology and bioinformatics, and that it does not veer off significantly into experimental biology or non-biological computation.
2. If there are unusual circumstances, such as an advisor moving to another school, the CBB DGS will work with the student to determine the best course of action for making progress with the student's research.
3. Students must meet with their Dissertation Committee at least yearly to discuss their progress. This meeting should be a joint Committee meeting, at which a formal evaluation form is completed by the committee. Such meetings may be held in the spring for the purpose of discussing the Dissertation Progress Report (discussed below), or they may be held at other times in the year.
4. After the student has been admitted to candidacy, he or she must prepare a Dissertation Progress Report (DPR) each year in the spring. This report maps the achievements of the past year and the goals for the upcoming year. This report should be emailed to each member of the Dissertation Committee, and each member should informally sign off on the DPR by email to the student, with copies to the Advisor and the DGS. The student is also required to submit the DPR through the Graduate School's online DPR submission process, by the required deadline. <http://www.yale.edu/sis/dpr>. The Advisor and the DGS must formally approve the DPR through the online system as well.
5. In the final year, the student writes the dissertation, distributes it to the Dissertation Committee, and then defends the dissertation in a presentation which any interested individual may attend. All of the Committee members are expected to attend the dissertation defense and to give comments on the dissertation. Committee comments must be addressed in the final version before it is submitted to the Graduate School. The Dissertation defense should be scheduled sufficiently in advance of Graduate School deadlines that there is time to make any necessary changes.
6. There are two deadlines for submission of the dissertation to the Graduate School: October 1 for a December degree and March 15 for a May degree. These deadlines may change slightly each year, so students are advised to check the academic calendar for the exact date. The Graduate School does not make exceptions to these deadlines
7. The Graduate School requires that the dissertation be read and evaluated by at least three Readers, at least two of whom have tenure or tenure track appointments at Yale. The Advisor typically recommends to the Graduate School whom the readers should be. Readers may be members of the Dissertation Committee.

8. Students should obtain a dissertation submission packet from the Graduate School. This contains several forms that the student needs to complete and submit along with four copies of the dissertation, including one unbound copy which goes to the Graduate School and three softbound copies which will be delivered to the Readers. The CBB Registrar will deliver the 3 copies to the Readers. The Readers then review the dissertation and fill out a Reader evaluation form for the Graduate School.
9. After all Reader evaluation forms have been returned to the Graduate School and any requested changes to the dissertation have been made, the CBB Director of Graduate Studies will sign a form recommending award of the PhD degree. Then the Graduate School Degree Committee and finally the Yale Corporation will vote to approve conferral of the degree.

### **MS Degree (en route to PhD)**

A Master's degree may be obtained by a CBB PhD student who is en route to obtaining a PhD degree or who leaves Yale prior to receiving a PhD degree. Requirements include: 1) completion of two years (four semesters) of study, 2) completion of required coursework (ten courses must be taken at Yale, including successful completion of three research rotations), with an average grade of High Pass (or higher), and 3) satisfying the Graduate School requirement of two Honors grades.

### **Career Planning**

Yale University, the BBS departments and the CBB program are placing increased emphasis on career planning through the creation of new resources and activities, such as career counseling, career fairs, industry networking opportunities, and alumni panels. Beginning in 2014-15, NIH expects that students (and post-doctoral fellows) supported on its training and research grants will be actively involved in career planning and in the preparation of Individual Development Plans (IDPs). Individual Development Plans will evolve over time, as students master various skills, focus their research interests, and investigate possible career paths. Self-assessment tools are available to entering students to establish a “baseline” assessment of skills, interests, and values. Repeat use of these tools in later years may assist a student in charting the development of career goals and the results of various career exploration activities.

## **CBB Events**

### **Seminars**

Many seminars related to computational biology and bioinformatics topics are held at Yale during the academic year. These will listed on the CBB calendar located at <http://tools.medicine.yale.edu/cbb/calendar/> and emails will be sent from the CBB Registrar to alert students to relevant talks.

Departments/Centers which sponsor seminars include:

MB&B - <http://medicine.yale.edu/events/mbb.aspx>

MCDB - <http://medicine.yale.edu/events/mcdb.aspx>

Genetics - <http://medicine.yale.edu/events/genetics.aspx>

Computer Science – <http://cpsc.yale.edu/calendar>

### **CBB Series and Happy Hours**

Held approximately twice a month from late September through July, the CBB Series includes talks from advanced CBB students, Journal Clubs presented by 2<sup>nd</sup> and 3<sup>rd</sup> year students, informal faculty talks, and outside speakers. All CBB students are expected to attend. During the fall and spring terms, these will usually be held at 4 pm on Wednesdays, followed by Happy Hours at 5 pm. Journal Clubs continue into the summer at weekly lunch meetings. Notification of the CBB Series and Happy Hours will be sent by email and will also be posted on the CBB Calendar: <http://tools.medicine.yale.edu/cbb/calendar/>.

### **Other Talks**

Talks given at the University and other institutions that may be of interest to the Computational Biology and Bioinformatics students are listed on the Gerstein Lab Bioinfo calendar <http://info.gersteinlab.org/Calendar>.

Events of particular CBB interest are marked “\*CBB\*.”

## Financial Support

PhD students in good academic standing receive a stipend, which increases yearly (in 2016-2017 the amount is \$34,450\*), full tuition, and health coverage. The Graduate School Payroll System (GSPS) is a semi-monthly payroll; checks are paid on the 15<sup>th</sup> and the last day of each month. Students usually have their checks deposited directly to their bank accounts. Financial support comes from University fellowships, National Institutes of Health (NIH) Training Grants, the National Science Foundation, and private foundations.

\* Students who apply for and win competitive external awards, such as NSF predoctoral fellowships, receive a \$4000 stipend bonus (for a total stipend of \$38,450 in 2016-17).

**Special note to international applicants** Financial aid for students who are neither U.S. citizens nor U.S. permanent residents is very limited. Although approximately 20% of each entering class is international, on average, we are able to admit less than 5% of our non-U.S. applicant pool. Please take this into consideration before applying to the Program.

## Health Coverage

If you are an enrolled student attending Yale at least half time and working towards a Yale degree, you receive many YHP services, including primary care, at no charge. You do not have to sign up or pay extra to obtain this coverage, which is called YHP Basic. Your status as a Yale University undergraduate, graduate, or professional student automatically makes you a student member of the health plan. If you are eligible for YHP Basic, you are also required by the University to obtain additional coverage for hospitalization and specialty care.

Here, you have two options:

1. You can purchase Yale Health Plan's Hospitalization/Specialty Coverage, with or without Prescription Plus. Full details on each of these plans, including dates of coverage and waiver deadlines, may be found in the student handbook, found on-line at <http://yalehealth.yale.edu/understand-your-coverage>.
2. You can have other coverage, either by being a dependent on someone else's plan (parents' or spouse's or domestic partner's) or by purchasing other coverage on your own. You will still be able to use YHP specialty services, but your other insurance will be billed for them as well as for any services obtained outside YHP, even if you are referred by a YHP clinician. If you choose option 2, you must give formal notice that you are waiving YHP Hospitalization/Specialty Coverage. You must give this notice each academic year. If you choose option 1 but do not want the additional Prescription Plus coverage that is automatically included, you must give formal notice of waiving Prescription Plus.

You provide notice in either situation by submitting a waiver form that you will receive by mail. If you have not received it by the beginning of the semester, call Member Services at 203-432-0246. If you are waiving YHP Hospitalization/Specialty Coverage, you will be asked to provide proof of alternate coverage. No proof of alternate coverage is needed if you

are waiving only Prescription Plus. Waivers for the full year or the fall term must be submitted annually by September 15, and by January 31 for those enrolling during the spring term.

If you do not submit this waiver by the deadline, you will be billed through your SFAS (Student Financial and Administrative Services) account for YHP Hospitalization/Specialty Coverage and Prescription Plus. Your SFAS account must be paid in full in order for you to register for classes or graduate.

If you waive YHP coverage you may change your mind and revoke your waiver by submitting a revoke waiver form before September 15 or January 31 deadlines. Your coverage will then begin and be retroactive to the beginning of the term. If you miss these deadlines you must wait until the next term in which you are eligible.

If you lose your non-YHP hospitalization insurance coverage, you must either revoke your waiver and enroll in a YHP plan or select another hospitalization insurance carrier. If you choose to enroll in the YHP plan you must do so within 30 days of the loss of other coverage. YHP's coverage begins the day following the other plan's termination date. Premiums are not prorated, and you must pay for the full-term cost of the YHP plan.

You may also enroll your eligible dependents in any of the plans for you which you are eligible. Details may be found in the online student handbook.

## **Housing**

Whether you are coming to Yale as a single student, or as a family, a variety of housing options are available to you. It is the goal of the Graduate Housing Office to provide opportunities for graduate and professional students to develop a sense of community while residing in University Housing. You may take advantage of social functions planned specifically for the dormitory or apartment where you live, joining a residence council, child playgroups and educational forums on relevant topics for students and their families. The possibilities are as varied as those who wish to participate.

University Housing is not available for all those who may be eligible due to space constraints. Applications are accepted starting April 1st and the assignment process will begin mid to late April.

The Graduate Housing experience is unique. The benefits and rewards of living in the Yale graduate community are long lasting.

**Graduate Housing** is administered out of two offices located on the ground floor of Helen Hadley Hall, 420 Temple Street. Office hours are Monday - Friday from 9:00 AM - 4:00 PM. Information: (203) 432-2167. The website at <http://www.yale.edu/gradhousing/> provides detailed information about the apartment and dormitory options, including locations, rates, and floor plans.

Yale's **Off-Campus Housing** office maintains a searchable database of housing available for rent in the New Haven area. The website at



<http://www.yale.edu/gradhousing/ochousing/index.html> is accessible from Yale networked computers or with a password obtained by emailing [offcampushousing@yale.edu](mailto:offcampushousing@yale.edu).

## **Graduate Writing Center**

The Graduate Writing Center (GWC) helps graduate students become prolific and successful academic writers. It offers assistance through academic writing workshops, panels with invited speakers, and individual consultations between students and writing tutors. GWC also offers dissertation support groups, boot camps and peer-review groups in order to reduce the stress that students often encounter during the process of writing a dissertation. The website, <http://ctl.yale.edu/writing/graduate>, provides a schedule of events and workshops and information on arranging individual consultations.