



# **Computational Biology & Bioinformatics at Yale**

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

**2020 - 2021 Handbook**

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## 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 while being able to do their dissertation research in the laboratory of a faculty member 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 adviser'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): <https://medicine.yale.edu/bbs/apply/>

We welcome your interest in Yale's CBB program.

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

## Participating Faculty

\* denotes Core Program Faculty (based on area of research and degree of involvement in the CBB program). For additional information, visit <http://cbb.yale.edu/faculty-labs>.

\*\* EE = Electrical Engineering, EEB = Ecology and Evolutionary Biology, EPH = Epidemiology and Public Health, IMED = Investigative Medicine, MB&B = Molecular Biophysics & Biochemistry, MCDB = Molecular, Cellular and Developmental Biology, ME = Mechanical Engineering

<b>Name</b>	<b>Department(s)</b>	<b>Location</b>	<b>Contact Information</b>
Marcus Bosenberg <i>Professor</i>	Dermatology	789 Howard Ave	<a href="mailto:marcus.bosenberg@yale.edu">marcus.bosenberg@yale.edu</a> 203-737-3484
Cynthia Brandt* <i>Professor</i>	Emergency Medicine	464 Congress Ave	<a href="mailto:cynthia.brandt@yale.edu">cynthia.brandt@yale.edu</a> 203-737-5762
Kei-Hoi Cheung* <i>Professor</i>	Emergency Medicine	464 Congress Ave	<a href="mailto:kei.cheung@yale.edu">kei.cheung@yale.edu</a> 203-737-5783
Ronald Coifman <i>Professor</i>	Mathematics	51 Prospect St	<a href="mailto:coifman-ronald@yale.edu">coifman-ronald@yale.edu</a> 203-432-1213
Chris Cotsapas <i>Associate Professor</i>	Genetics Neurology	300 George St	<a href="mailto:chris.cotsapas@yale.edu">chris.cotsapas@yale.edu</a> 203-737-2896
Forrest Crawford <i>Associate Professor</i>	Biostatistics	350 George St	<a href="mailto:forrest.crawford@yale.edu">forrest.crawford@yale.edu</a> 203-785-6125
Stephen Dellaporta <i>Professor</i>	MCDB**	165 Prospect St	<a href="mailto:stephen.dellaporta@yale.edu">stephen.dellaporta@yale.edu</a> 203-432-3895
Richard Flavell <i>Professor</i>	Immunobiology	300 Cedar St	<a href="mailto:richard.flavell@yale.edu">richard.flavell@yale.edu</a> 203-737-2216
Joel Gelernter <i>Professor</i>	Genetics	950 Campbell Ave	<a href="mailto:joel.gelernter@yale.edu">joel.gelernter@yale.edu</a> 203-932-5711
<b>Mark Gerstein*</b> <i>Professor</i>	Computer Science MB&B**	266 Whitney Ave	<a href="mailto:mark.gerstein@yale.edu">mark.gerstein@yale.edu</a> 203-432-6105
Jeffrey Gruen <i>Professor</i>	Genetics IMED** Pediatrics	464 Congress Ave	<a href="mailto:jeffrey.gruen@yale.edu">jeffrey.gruen@yale.edu</a> 203-688-2320

Murat Gunel <i>Professor</i>	Genetics Neurobiology	789 Howard Ave	<a href="mailto:murat.gunel@yale.edu">murat.gunel@yale.edu</a> 203-737-2096
Ira Hall <i>Professor</i>	Genetics	300 Cedar St	<a href="mailto:ira.hall@yale.edu">ira.hall@yale.edu</a>
Samah Jarad <i>Assistant Professor</i>	Emergency Medicine	300 George St	<a href="mailto:samah.fodeh@yale.edu">samah.fodeh@yale.edu</a> 203-737-5806
Amy Justice <i>Professor</i>	EPH**	950 Campbell Ave	<a href="mailto:amy.justice@yale.edu">amy.justice@yale.edu</a> 203-932-5711
Naftali Kaminski <i>Professor</i>	Medicine	300 Cedar St	<a href="mailto:naftali.kaminski@yale.edu">naftali.kaminski@yale.edu</a> 203-737-4612
Steven Kleinstein* <i>Professor</i>	Pathology	300 George St	<a href="mailto:steven.kleinstein@yale.edu">steven.kleinstein@yale.edu</a> 203-785-6685
Yuval Kluger* <i>Professor</i>	Pathology	300 George St	<a href="mailto:yuval.kluger@yale.edu">yuval.kluger@yale.edu</a> 203-737-6262
Smita Krishnaswamy <i>Assistant Professor</i>	Genetics	51 Prospect Ave	<a href="mailto:smita.krishnaswamy@yale.edu">smita.krishnaswamy@yale.edu</a> 203-785-7833
Harlan Krumholz <i>Professor</i>	Medicine	1 Church St	<a href="mailto:harlan.krumholz@yale.edu">harlan.krumholz@yale.edu</a> 203-764-5888
Morgan Levine <i>Assistant Professor</i>	Pathology	310 Cedar Street	<a href="mailto:morgan.levine@yale.edu">morgan.levine@yale.edu</a> 818-437-6791
Haifan Lin <i>Professor</i>	Cell Biology Genetics	10 Amistad St	<a href="mailto:haifan.lin@yale.edu">haifan.lin@yale.edu</a> 203-785-6215
Benjamin Machta <i>Assistant Professor</i>	Physics	217 Prospect St	<a href="mailto:benjamin.machta@yale.edu">benjamin.machta@yale.edu</a> 203-432-3650
Robert McDougal <i>Assistant Professor</i>	Biostatistics	300 George St	<a href="mailto:robert.mcdougal@yale.edu">robert.mcdougal@yale.edu</a> 203-737-4828
Kathryn Miller- Jensen <i>Associate Professor</i>	Engineering	55 Prospect St	<a href="mailto:kathryn.miller-jensen@yale.edu">kathryn.miller-jensen@yale.edu</a> 203-432-4265
James Noonan <i>Associate Professor</i>	Genetics	333 Cedar St	<a href="mailto:james.noonan@yale.edu">james.noonan@yale.edu</a> 203-737-1922

Corey O'Hern* <i>Professor</i>	ME** Physics	9 Hillhouse Ave	<a href="mailto:corey.ohern@yale.edu">corey.ohern@yale.edu</a> 203-432-4258
Lajos Pusztai <i>Professor</i>	Oncology	300 George St	<a href="mailto:lajos.pusztai@yale.edu">lajos.pusztai@yale.edu</a> 203-737-8309
Anna Marie Pyle <i>Professor</i>	MCDB**	219 Prospect St	<a href="mailto:anna.pyle@yale.edu">anna.pyle@yale.edu</a> 203-432-5633
David Stern <i>Professor</i>	Pathology	310 Cedar St	<a href="mailto:df.stern@yale.edu">df.stern@yale.edu</a> 203-785-4832
Jeffrey Townsend <i>Professor</i>	Biostatistics EEB**	135 College St	<a href="mailto:jeffrey.townsend@yale.edu">jeffrey.townsend@yale.edu</a> 203-737-7042
Gunter Wagner <i>Professor</i>	EEB**	140 West Campus Dr	<a href="mailto:gunter.wagner@yale.edu">gunter.wagner@yale.edu</a> 203-432-9998
Anita Wang <i>Associate Professor</i>	Biostatistics	60 College St	<a href="mailto:zuoheng.wang@yale.edu">zuoheng.wang@yale.edu</a> 203-737-2672
<b>Hongyu Zhao*</b> <i>Professor</i>	EPH** Statistics	300 George St	<a href="mailto:hongyu.zhao@yale.edu">hongyu.zhao@yale.edu</a> 203-785-3613
Steven Zucker <i>Professor</i>	Computer Science EE**	51 Prospect St	<a href="mailto:steven.zucker@yale.edu">steven.zucker@yale.edu</a> 203-432-6434

## **CBB Graduate Program Administration**

### **Co-Directors of Graduate Studies**

Mark Gerstein	266 Whitney Avenue, BASS 432A	203-432-6105
Hongyu Zhao	300 George Street, Suite 503	203-785-3613

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 or a faculty member or adviser, the DGS' are the ones to approach.

### **Graduate Program Registrar**

Lisa Sobel	300 George Street (Suite 501)	203-737-6029
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The Graduate School Registrar keeps the graduate student files. She enters graduate student payroll and provides administrative support to the students, the Directors of Graduate Studies, and the Admissions Committee. She also handles curriculum, department fellowship information, student forms, academic schedules and room reservations.

## CBB Graduate Students

<b>Name</b>	<b>Year</b>	<b>Advisor(s)</b>	<b>Lab Location(s)</b>
Edel Aron	3	Steven Kleinstein	300 George St
Ana Berthel	2	N/A	N/A
Egbert Castro	3	Smita Krishnaswamy	51 Prospect St
David Chang	5	Cynthia Brandt Hongyu Zhao	300 George St
Daniel Chawla	6	Steven Kleinstein	300 George St
Evan Cudone	4	Robert McDougal	300 George Street
Sarah Dudgeon	1	N/A	N/A
J. Nick Fisk	4	Jeffrey Townsend	135 College Street
Jiahao Gao	4	Mark Gerstein	266 Whitney Avenue
Scott Gigante	4	Smita Krishnaswamy Ronald Coifman	51 Prospect Street
Guannan Gong	3	Harlan Krumholz	1 Church Street
Alex Grigas	3	Corey O'Hern	9 Hillhouse Avenue
Jeremy Gygi	2	Steven Kleinstein	300 George St
Pranav Kantroo	4	Gunter Wagner Benjamin Machta	840 West Campus Drive 217 Prospect Street
Noah Lee	1	N/A	N/A
Diana Leung	2	Morgan Levine Yuval Kluger	300 George St
Wes Lewis	2	N/A	N/A
Tianxiao Li	4	Mark Gerstein	266 Whitney Avenue
Xiaotong Li	7	Mark Gerstein Lajos Pusztai	266 Whitney Avenue 300 George St
Jason Liu	1	N/A	N/A
Wei Liu	4	Hongyu Zhao	300 George St
Kevin Lopez	6	Cynthia Brandt	300 George St
Jeffrey Mandell	3	Jeffrey Townsend	135 College Street



Yaroslav Markov	2	Morgan Levine	300 George St
Hussein Mohsen	5	Mark Gerstein	266 Whitney Avenue
Nir Neumark	5	Ronald Coifman Naftali Kaminski	1 Church Street 300 Cedar Street
Eric Ni	2	Mark Gerstein	266 Whitney Avenue
Rihao Qu	4	Yuval Kluger Richard Flavell	300 George St 300 Cedar St
A. Ram	1	N/A	N/A
Vimig Socrates	2	Cynthia Brandt	300 George St
Andrea Tamminga	2	Chris Cotsapas	300 George St
Kyra Thrush	3	Morgan Levine	300 George St
Aarthi Venkat	2	Smita Krishnaswamy	51 Prospect Street
Jiawei Wang	5	Hongyu Zhao	300 George St
Mamie Wang	2	Steven Kleinstein Yuval Kluger	300 George St
Junchen Yang	2	Yuval Kluger	300 George St
Yixuan Ye	4	Hongyu Zhao	300 George St
Zhaolong Yu	5	Hongyu Zhao	300 George St
Maryam Zekavat	2	Hongyu Zhao	300 George St
Geyu Zhou	4	Hongyu Zhao	300 George St
Biqing Zhu	2	Hongyu Zhao	300 George St

## Noteworthy Numbers & Addresses

### Academic Deans

Associate Dean of Grad Academic Support	<b>Richard Sleight</b> Warner House, 1 Hillhouse Ave	<a href="mailto:richard.sleight@yale.edu">richard.sleight@yale.edu</a> 203-432-2744
Assistant Dean	<b>Robert Harper-Mangels</b> Warner House, 1 Hillhouse Ave	<a href="mailto:robert.harper-mangels@yale.edu">robert.harper-mangels@yale.edu</a> 203-432-2744

### BBS Program

Director	<b>Craig Roy</b> 295 Congress Ave	<a href="mailto:craig.roy@yale.edu">craig.roy@yale.edu</a> 203-737-2408
Administrative Director	<b>John Alvaro</b> 37-55 College St	<a href="mailto:john.alvaro@yale.edu">john.alvaro@yale.edu</a> 203-785-3735

### Graduate Admissions Office

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

Director	<b>Leah Phinney</b> Warner House, 1 Hillhouse Ave	<a href="mailto:leah.phinney@yale.edu">leah.phinney@yale.edu</a> 203-432-2749
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### Graduate Student Life Office (McDougal Graduate Student Center)

Assistant Dean of Student Life	<b>Lisa Brandes</b> 135 Prospect St	<a href="mailto:lisa.brandes@yale.edu">lisa.brandes@yale.edu</a> 203-432-8895
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### Financial Aid Office

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

Director	<b>Sara Estrom</b> 246 Church St	<a href="mailto:sara.estrom@yale.edu">sara.estrom@yale.edu</a> 203-432-7980
Assistant Director	<b>Kellie Webb</b> 246 Church St	<a href="mailto:kellie.webb@yale.edu">kellie.webb@yale.edu</a> 203-432-2899

### Office of Diversity and Equal Opportunity

Associate Dean and Director	<b>Michelle Nearon</b> Warner House, 1 Hillhouse Ave	<a href="mailto:michelle.nearon@yale.edu">michelle.nearon@yale.edu</a> 203-436-1301
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### University Registrar's Office

*The university registrar office 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.*

University Registrar	<b>Emily Shandley</b> 246 Church St	<a href="mailto:emily.shandley@yale.edu">emily.shandley@yale.edu</a> 203-432-2337
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## Other University Offices

<b>Student Financial and Administrative Services (SFAS)</b> Bursar's Office	246 Church St 203-432-2700
<b>International Students &amp; Scholars Office</b>	421 Temple St 203-432-2305
<b>International Center</b>	421 Temple St 203-432-2305
<b>Night Student Security</b> Transit Service	203-432-6330
<b>University Police</b>	101 Ashmun St 203-432-4400 (dispatch)
<b>Yale Visitor Center</b>	149 Elm St 203-432-2300
<b>Yale University Health Service/Yale Health Plan</b> Urgent Care (24/7) Student Health General Information	55 Lock St 203-432-0123 203-432-0312 203-432-0246

## Requirements & Curriculum Overview

### MS Requirements (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 with an average of a High Pass\*
  - Ten courses must be taken at Yale
  - This coursework includes the successful completion of three research rotations
3. Satisfaction of the Graduate School requirement of at least two Honors\* grades

\*Graduate School Grading: Honors (H), High Pass (HP), Pass (P), Fail (F) plus Satisfactory/Unsatisfactory (Sat/Unsat)

### PhD Requirements:

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, the co-directors are willing to meet with students to help them 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 courses as follows:
  - three required graduate courses in computational biology and bioinformatics,
  - two graduate courses in the biological sciences,
  - two graduate courses in areas of informatics,
  - two 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 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 4th years, (graded as credit or non-credit)
- participate in the 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 adviser (or co-advisers) 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 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 following CBB core courses (found in **bold** below): CB&B 752, CB&B 740 or CB&B 561, and CB&B 750 or CB&B 562 and the year-long sequence of lab rotations (711, 712, 713).

- CB&B 523b Biological Physics
- CB&B 550 Introduction to Neuroinformatics
- CB&B 555a Unsupervised Learning for Big Data
- **CB&B 561a Modeling Biological Systems I**
- **CB&B 562b Modeling Biological Systems II**
- CB&B 567b Topics in Deep Learning: Methods and Biomedical Applications (not given in 2020-2021)
- CB&B 634a Computational Methods in Informatics
- CB&B 638a Clinical Database Management Systems and Ontologies
- CB&B 645b Statistical Methods in Computational Biology (not given in 2020-2021)
- CB&B 647b Statistical Methods in Human Genetics (not given in 2020-2021)
- CB&B 663b Deep Learning Theory and Applications (not given in 2020-2021)
- **CB&B 711 1st Lab Rotation**
- **CB&B 712 2nd Lab Rotation**
- **CB&B 713 3rd Lab Rotation**
- **CB&B 740a Introduction to Health Informatics**

- CB&B 745b Advanced Topics in Machine Learning and Data Mining (not given in 2020-2021)
- **CB&B 750b Core Topics in Biomedical Informatics**
- **CB&B 752b Biomedical Data Science: Mining and Modeling**

## **Courses in Biological Sciences**

Courses are available in many biology-related departments, including Cell Biology (CBIO), Ecology and Evolutionary Biology (E&EB), Engineering and Applied Science (ENAS), Genetics (GENE), Immunology (IBIO), Molecular Biophysics and Biochemistry (MB&B), Molecular, Cellular, and Developmental Biology (MCDB), Pathology (PATH) and Physiology (PHYS).

Courses that CBB students have taken include the following:

- CBIO 602a Molecular Cell Biology
- E&EB 525b Evolutionary Biology
- ENAS 517b Methods and Logic in Interdisciplinary Research [for students in PEB]
- ENAS 991a Integrated Workshop [for students in PEB]
- GENE 625a Basic Concepts: Genetics Analysis
- GENE 777b Mechanisms of Development
- IBIO 530a Biology of the Immune System
- MB&B 600a Principles of Biochemistry I
- MB&B 602a Molecular Cell Biology
- MB&B 743b Advanced Eukaryotic Molecular Biology
- MCDB 550a Physiological Systems [for students in MRSP]
- MCDB 570b Biotechnology
- PATH 650b Cellular and Molecular Biology of Cancer [for students in CBTP]
- PATH 690a Molecular Mechanisms of Disease [for students in MRSP]

## **Informatics Courses**

### Computer Science and Related Courses

Courses are available in Computer Science and other departments. Courses that CBB students have taken include the following:

- CPSC 524b Parallel Programming Techniques
- CPSC 537a Introduction to Database Systems
- CPSC 545a Introduction to Data Mining (not given in 2020-2021)
- CPSC 570b Artificial Intelligence

### Statistics Courses

Many CBB students have taken the following statistics courses:

- S&DS 538a Probability and Statistics for Scientists
- S&DS 645b Statistical Methods in Genetics and Bioinformatics (not given in 2020-2021)

- S&DS 660b Multivariate Statistical Methods (not given in 2020-2021)

Other courses that students have taken include the following:

- BIS 623a Applied Regression Analysis
- S&DS 530ab 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 Data Mining and Machine Learning (not given in 2020-2021)

### **Research Ethics Courses**

These half-semester courses are required by the NSF and must be taken by first-years and by fourth-years. The first-year course is typically shared with several other BBS tracks and meets once a week for 10 sessions. The fourth-year course will meet once as a large group and one to two times as a program.

- CB&B 601b Responsible Conduct of Research
- BBS 503b RCR Refresher for Senior BBS Students

## Optional Focus on Biomedical Data Science

This focus exposes students to data science training and educational initiatives at Yale. Its 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, Brandt and Gerstein). 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. Zhao).

At least **four** other courses taken must have a major focus on biomedical data sciences. There are many such courses, including:

- CPSC 365b Algorithms
- CPSC 462 Graphs and Networks (not given in 2020-2021)
- CPSC 540b Numerical Computation (not given in 2020-2021)
- MATH 244ab Discrete Mathematics
- MATH 246ab Ordinary Differential Equations
- S&DS 530ab Data Exploration and Analysis
- S&DS 538a Probability and Statistics
- 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 660 Multivariate Statistical Methods (not given in 2020-2021)
- S&DS 661b Data Analysis
- S&DS 665 Data Mining and Machine Learning (not given in 2020-2021)



## Optional Focus on Translational Informatics

Translational research is concerned with bringing bioscience research discoveries into patient care. This 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. The overall CBB curriculum is unchanged, but the Translational Informatics focus makes the following specific course requirements.

The following courses **must** be taken (inline with the standard CBB requirements):

- CB&B 752b Biomedical Data Science: Mining and Modeling
- Two of:
  - CB&B 561a Modeling Biological Systems I
  - CB&B 562b Modeling Biological Systems II
  - CB&B 740a Introduction to Health Informatics
  - CB&B 750b Core Topics in Biomedical Informatics

**At least two** of the other courses taken must have a major focus on clinical medicine and/or disease. There are many such courses, including:

- BIS 540a Fundamentals of Clinical Trials
- CBIO 600a/601b Science at the Frontiers of Medicine
- GENE 500b Principles of Human Genetics (not given in 2020-2021)
- IBIO 530a Biology of the Immune System
- NSCI 507b Cellular and Molecular Mechanisms of Neurological Disease (not given in 2020-2021)
- PATH 650b Cellular & Molecular Biology of Cancer

## 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 adviser. Three credits will be given for the 3 rotation sequence, which is graded as pass/fail.

Students will be expected to give short presentations on two of their rotation projects to their fellow first-years and select faculty members. The first presentation will be after the first two rotations and the second will be after the third rotation.

This is the schedule for 2020-2021:

- Aug 31<sup>st</sup> to Sep 11<sup>th</sup> - Rotation Shopping Period
- Sep 14<sup>th</sup> to Oct 16<sup>th</sup> - Rotation 1
- Oct 19<sup>th</sup> to Nov 20<sup>th</sup> - Rotation 2 (could be extended at student request)
- Jan 4<sup>th</sup> to Feb 5<sup>th</sup> - Rotation 3
- Feb 8<sup>th</sup> to Mar 12<sup>nd</sup> - Rotation 4 (students can begin selecting thesis lab at the end of this rotation)
- Mar 15<sup>th</sup> to Apr 16<sup>th</sup> - Rotation 5 (optional)

*Due to COVID-19, we have altered the standard 3-rotation schedule and will continue to update the requirements and expectations above as policies evolve.*

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 website. 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 and expected to attend** either the MBB Retreat or the MCDB retreat.
- 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 students and PIs are required to submit evaluations sent by the registrar at the end of the rotation. It is expected that the given forms will be returned within a two-week period. The student's version will be added to the rotation notebook for future students to consult.

## **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 counts for a portion of the normal stipend for the appropriate term. It is strongly recommended that students wait until the 4th year (after qualification) to complete these appointments.

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, PhD students should expect to spend no more than 10 hours per week on teaching and assignments (including the usual expectation of grading exams). TAs and faculty should remain clear on what is expected of their assignment and it is imperative that TAs are aware of exam deadlines and make arrangements with faculty in case there should be any conflicts.

As an interdepartmental program, CBB allows teaching assignments in a number of departments. The CBB Registrar maintains a list of all the courses in which CBB students have been TAs which serves as a useful starting point for finding an appointment. If students are interested in teaching outside BBS, e.g., Computer Science, Bioengineering, Statistics, etc. they should contact the registrar within each program.

In June of 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 included online form indicating which courses they would like to TA in by the given deadline (or preferably 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.

## Qualifying Exam, Admission to Candidacy and the 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 Exam Committee. **The adviser must be a member of the Dissertation Committee.** The Dissertation Committee's role is to guide the student towards the PhD degree and to approve the thesis.

### Qualifying Exam Process

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 time-frame in which these conditions must be fulfilled, in order for the student to pass the Qualifying Exam.

#### Committee Selection:

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 adviser may be a member of the QE Committee, but does not need to be.
- The Committee may contain members outside of Yale if necessary.
- The composition of the QE Committee must be approved by the adviser and the CBB Director of Graduate Studies (DGS).
- The adviser designates a Chair of the QE Committee. This may be the adviser, but does not need to be.

The student then notifies the CBB Graduate Registrar of the members and chair of the QE Committee.

#### Committee Meetings:

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.*

#### PRE-QUALIFYING EXAM MEETING

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. There will typically be 45 minutes for the proposal followed by 15 minutes of questions, although this can vary depending upon your Committee.

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.

### **QUALIFYING EXAM MEETING**

For the second QE meeting (typically 2-3 months later), 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.

Committee members may provide further guidance on the exact structure of the prospectus. *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) for approximately 1 to 1.5 hrs, then 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.
- Participation of the adviser in the Qualifying Exam is desirable but not required.

### **Admission to Candidacy:**

The Chair of the QE Committee informs the CBB DGS and Registrar of the results of the QE. After the student passes the QE, the CBB program recommends to the Graduate School that the student be admitted to candidacy for the PhD. Unlike many other programs and departments within BBS, CBB does not have a separate process for admission to candidacy.

- A copy of the prospectus should be sent by the student to the CBB Registrar.
- The Registrar will then send a copy of the prospectus along with the relevant forms to the Graduate School.
- The student must 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 and Procedures

A general checklist from the Graduate School can be found at <https://gsas.yale.edu/academics/dissertations/submission-process>.

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 Adviser and the CBB DGS, the membership of the Dissertation Committee may be changed from the QE Committee. **The adviser 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 adviser 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 adviser 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. The adviser 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 Adviser 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.

## 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. They are sent out annually to all current students by the department registrar.

## CBB Events

### Seminars

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

Departments/Centers which sponsor seminars include CBDS, Computer Science, MB&B, MCDB and Genetics.

### CBB Series

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 a social 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.

### 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 yearly-increasing stipend (in 2020-2021 the amount is \$37,300\*), full tuition (for the first four years), and health coverage. The Graduate School Payroll System (GSPS) is a semi-monthly payroll; checks are paid on the 15th and the last day of each month. Incoming students will receive their first check on August 31st (to be picked up from the department registrar).

\* *Students who win competitive outside awards such as NIH National Research Service Awards (NRSA) or NSF fellowships receive a stipend bonus of \$4,000 (for a total stipend of \$41,300 in 2020-21).*

Students usually have their checks deposited directly to their banks, which can be setup and managed through Payment Elections in Workday. The university does **not** withhold federal or state taxes from stipends, but it does still report income to the IRS. All students are responsible for paying taxes on the amount of their stipend that exceeds expenses directly related to their studies. Connecticut also requires a property tax on all cars with a rate determined on a city basis.

Financial support comes from university fellowships, National Institutes of Health (NIH) Training Grants, the National Science Foundation, and private foundations. First year students are provided with at least \$350 that can be used for the purchase of textbooks in the first semester or towards travel to a conference in the first year (original receipts or invoices are required for reimbursement).

\* *PhD students with families are also provided an annual subsidy of \$4,700 for having a child under 18 (with an additional \$1,000 per any other child under 6) by the Graduate School.*

### **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, we are able to admit less than 5% (on average) of our non-U.S. applicant pool. Please take this into consideration before applying to the program.

## Health Coverage

All graduate students are considered student members of Yale's health plan.

- Students are automatically enrolled in Yale Health Basic Coverage **at no charge** and do NOT need do anything else for individual coverage. This coverage includes primary care.
- Students also are automatically enrolled in Yale Health Hospitalization/Specialty Care Coverage. PhD students do not have to pay for this coverage, but it can be waived by the deadline if desired.
  - Proof of alternate coverage will **have** to be provided if waiving this additional coverage.
  - 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 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.

*Full details on each of these plans (including dates of coverage, services included and waiver deadlines) may be found in the student handbook (pdf) or online.*

Free mental health counseling is also available and eligible dependents may be enrolled in any of the plans for which you are eligible. Dental and eye coverage can be purchased, but are not required.

Students can have other coverage, either by being a dependent on someone else's plan (parents' or spouses' or domestic partners') or by purchasing other coverage on their own. YHP specialty services can still be used in this scenario, but the 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 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.

## Housing

### Graduate 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.
- Call (203) 432-8270 for apartment information and (203) 432-2167 for dormitory information.
- The website at <http://gradhousing.yale.edu/> provides detailed information about the apartment and dormitory options, including locations, rates, and floor plans.

### Off-Campus Housing:

Yale's Off-Campus Housing office maintains a searchable database of housing available for rent in the New Haven area. The website at <http://offcampus.yale.edu/> is accessible from Yale networked computers or with a password obtained by emailing [offcampushousing@yale.edu](mailto:offcampushousing@yale.edu).

Many students have also found housing through online sources such as rental website listings and social media postings.

## 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.