



Computational Biology & Bioinformatics at Yale

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

2023 - 2024 Handbook

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Introduction

Computational Biology and Biomedical informatics (CBB) is a rapidly developing interdisciplinary field that requires an understanding of computational and informatics methods applied to a specific domain (e.g., health or biological systems). It represents a **data science** perspective applied to the biomedical domain.

Our program has research **foci** at the interface of informatics and biomedicine, genomics, and computational modeling of biological systems. In particular, the systematic acquisition of data made possible by genomics, proteomics, electronic health records, biosensors, and imaging technologies has created a tremendous gap between available data and their biomedical interpretation. Given the rate of data generation, it is recognized that this gap will not be closed with direct experimentation. Computational and statistical approaches to understanding biological and biomedical systems also provide an essential vehicle to help close the gap. These activities include modeling biomedical and biophysical processes, large-scale database development, data mining, machine learning, and high-performance computing.

Yale has an **interdepartmental** CBB PhD program. The advantage of such a program is that CBB students complete the CBB curriculum while being able to perform dissertation research in the laboratory of a faculty member in any relevant department at Yale; students do not have to satisfy the Ph.D. 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 Steven Kleinstein, 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>.

** BIDS = Biomedical Informatics and Data Science, BME = Biomedical Engineering, CEE = Chemical and Electrical Engineering, 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, RDI = Radiology and Biomedical Imaging, S&DS = Statistics and Data Science

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CBB Graduate Program Administration

Co-Directors of Graduate Studies

Mark Gerstein	Bass 432A, 266 Whitney Avenue	203-432-6105
Steven Kleinstein	Suite 505, 300 George Street	203-785-6685

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	9 th Floor, 100 College Street	203-737-6029
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The Graduate School Registrar keeps the graduate student files. They enter graduate student payroll and provides administrative support to the students, the Directors of Graduate Studies, and the Admissions Committee. They also handle curriculum, department fellowship information, student forms, academic schedules, and room reservations.

The registrar can be contacted at cbb-registrar@yale.edu.

Student Leadership

Student Chairs

Elections for new student chairs are held in in the spring semester for terms that start in June. The faculty mentors for each chair are listed in parentheses.

- **Diversity, Equity, and Inclusion Chair:** Huan Li (Mary-Anne “Annie” Hartley)
- **Outreach Chair:** Donglu Bai (David van Dijk)
- **Peer Mentorship Chair:** Wesley Lewis (Robert McDougal)
- **Social Chair:** Jessica Kasamoto (Jeffrey Townsend)

Student Government

- **GSA Representatives:** Aarthi Venkat and Jess Graham

Student Organizing Committee

- Ruiqi Li and Burhan Sabuwala

CBB Graduate Students

Name	Year	Adviser(s)
Ardavan Abiri	2	Sidi Chen
Philip Adejumo	3	Rohan Khera
Kriti Agrawal	3	Yuval Kluger & Richard Flavell
Edel Aron	6	Steven Kleinstein
Donglu Bai	3	Mark Gerstein
Trevor Brokowski	1	N/A
Egbert Castro	6	Smita Krishnaswamy
Yuhang Chen	3	Mark Gerstein
Andy Chu	3	Mark Gerstein
Christine Dien	1	N/A
Mingze Dong	3	Yuval Kluger & Rong Fan
Sarah Dudgeon	4	Wade Schulz
Jenel Fraij Armstrong	2	Alfred Higgins-Chen
Jess Graham	2	David Braun
Alex Grigas	6	Corey O'Hern
Jeremy Gygi	5	Steven Kleinstein
Ao Huang	2	John Tsang
Cole Jensen	3	Steven Kleinstein
Andrew Jia	3	Chris Cotsapas
Yunzhe Jiang	3	Mark Gerstein
Kevin Jin	1	N/A
Pranav Kantroo	7	Gunter Wagner & Benjamin Machta
Jessica Kasamoto	2	Alfred Higgins-Chen
Noah Yann Lee	4	Steven Kleinstein
Wes Lewis	5	Yuval Kluger
Huan Li	3	Ted Melnick

Keyi “Koi” Li	2	Yuval Kluger & Rong Fan
Ruiqi Li	3	Yuval Kluger
Tianxiao Li	7	Mark Gerstein
Xinyun Li	1	N/A
Jason Liu	4	Mark Gerstein
Tianyu Liu	2	Hongyu Zhao
Yuntian Liu	1	N/A
Chang Lu	2	Yuval Kluger
Aatmik Mallya	1	N/A
Jeffrey Mandell	6	Jeffrey Townsend
Yaroslav Markov	5	Alfred Higgins-Chen
Eric Ni	5	Mark Gerstein
Rihao Qu	7	Yuval Kluger & Richard Flavell
A. Ram	4	Forrest Crawford
Burhan Sabuwala	2	Steven Kleinstein
Raghav Sehgal	4	Alfred Higgins-Chen
Vimig Socrates	5	Cynthia Brandt
Anna Su	2	N/A
Jake Sumner	3	Corey O’Hern
Andrea Tamminga	5	Chris Cotsapas
Aarthi Venkat	5	Smita Krishnaswamy
Leona Wang	1	N/A
Meng “Mamie” Wang	5	Steven Kleinstein & Yuval Kluger
Xin Xin	3	Mark Gerstein
Junchen Yang	5	Yuval Kluger
Michelle Yu	4	Mark Gerstein
Dingyao Zhang	3	Mark Gerstein
Weihao Zhao	2	Mark Gerstein

Lucy Zheng	1	N/A
Suchen Zheng	2	Mark Gerstein
Biqing Zhu	5	Hongyu Zhao

Noteworthy Numbers & Addresses

Academic Deans

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BBS Program

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Administrative Director	John Alvaro 37-55 College St	john.alvaro@yale.edu 203-785-3735

Graduate Admissions Office

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

Director	Leah Phinney Warner House, 1 Hillhouse Ave	leah.phinney@yale.edu 203-432-2749
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Graduate Student Life Office (McDougal Graduate Student Center)

Assistant Dean of Student Life	Matthew Tanico 135 Prospect St	matthew.tanico@yale.edu 203-432-8895
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Financial Aid Office

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

Director	Sara Estrom 246 Church St	sara.estrom@yale.edu 203-432-7980
Assistant Director	Kellie Webb 246 Church St	kellie.webb@yale.edu 203-432-2899

Office of Diversity and Equal Opportunity

Associate Dean and Director	Michelle Nearon Warner House, 1 Hillhouse Ave	michelle.nearon@yale.edu 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	Emily Shandley 246 Church St	emily.shandley@yale.edu 203-432-2337
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Other University Offices

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

Requirements & Curriculum Overview

MS Requirements:

Requirements include:

1. Completion of two years/four semesters of study
2. Completion of required coursework with an average of a High Pass*
 - Ten credits 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)

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.

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:

- complete at least **ten credits** through specific 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 740, CB&B 752, and either CB&B 750 or CB&B 562 plus the year-long sequence of lab rotations (711, 712, 713).

- CB&B 523b: Biological Physics (*every other year*)
- CB&B 550a: Introduction to Neuroinformatics
- CB&B 555a: Unsupervised Learning for Big Data
- **CB&B 562b: Modeling Biological Systems II**
- CB&B 567b: Topics in Deep Learning: Methods and Biomedical Applications (*every other year*)
- CB&B 634a: Computational Methods in Informatics
- CB&B 638a: Clinical Database Management Systems and Ontologies
- CB&B 645b: Statistical Methods in Computational Biology
- CB&B 647b: Statistical Methods in Human Genetics
- CB&B 663b: Deep Learning Theory and Applications
- **CB&B 711a: 1st Lab Rotation**
- **CB&B 712b: 2nd Lab Rotation**
- **CB&B 713b: 3rd Lab Rotation**
- **CB&B 740a: Introduction to Health Informatics**
- CB&B 745b: Advanced Topics in Machine Learning and Data Mining

- **CB&B 750b: Core Topics in Biomedical Informatics**
- **CB&B 752b: Biomedical Data Science: Mining and Modeling** [not offered in 2023-2024]

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
- 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
- S&DS 660b: Multivariate Statistical Methods

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

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 Focuses:

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
- CPSC 540b: Numerical Computation

- 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
- S&DS 661b: Data Analysis
- S&DS 665: Data Mining and Machine Learning

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 (in line with the standard CBB requirements):

- CB&B 740a: Introduction to Health Informatics
- CB&B 750b: Core Topics in Biomedical Informatics
- CB&B 752b: Biomedical Data Science: Mining and Modeling

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
- IBIO 530a: Biology of the Immune System
- NSCI 507b: Cellular and Molecular Mechanisms of Neurological Disease
- 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. *Each rotation is approximately 7 weeks long (not including breaks).*

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.

The schedule for 2023-2024 (including official Yale holidays) is:

- Shopping: until Sep 5
- Rotation 1: Sep 11 - Oct 27
- Rotation 2: Oct 30 - Jan 12
- Rotation 3: Jan 15 - Mar 1
- Rotation 4: Mar 4 - May 3 [optional]

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:

- The CBB program schedules sessions where certain CBB faculty describe their research interests. The faculty talks for Fall 2020 were recorded and are available on [YouTube](https://tinyurl.com/y5r2qlz5) (<https://tinyurl.com/y5r2qlz5>).
- 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.

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 Fellowships

All CBB PhD students are required to serve as teaching fellows in **two assignments (one per term)** regardless of level during their training period. Appointments as a teaching fellow 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). TFs and faculty should remain clear on what is expected of their assignment, and it is imperative that TFs 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 TFs 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 TF 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 TF 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. *Students should also notify the CBB registrar of confirmed teaching positions.*

Examples of courses in which CBB students have been TFs include the following:

- CBB 645b: Statistical Methods in Genetics and Bioinformatics
- CBB 750b: Core Topics in Biomedical Informatics
- CBB 752a: Biomedical Data Science: Mining and Modeling
- MATH 215b: Introduction to Management Science: Probabilistic Models
- MCDB 200b: Molecular Biology
- STAT 538a: Probability and Statistics for Scientists
- STAT 660b: Multivariate Statistical Methods for the Social Sciences

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 Fellowships.*

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. This is usually demonstrated by a first-author or joint first-author paper in a respected journal in computational biology or bioinformatics.
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 each dissertation be read and evaluated by at least three people. The number and necessary qualifications of the readers are specified by the Graduate School (see <http://catalog.yale.edu/gsas/policies-regulations/degree-requirements/#dissertation>).
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.

Peer Mentorship

As of 2020, the CBB program offers a peer mentoring program intended to help first-year students adjust to being in graduate school, living in New Haven, and navigating a PhD at Yale. Mentors are experienced current students who volunteer their time to befriend, guide, and support new students. Mentors and mentees are matched using the Gale-Shapley algorithm on their survey results. All new students are encouraged to participate, but **participation is not required**.

This year we will be having large group meetings (where all mentors and mentees are encouraged to attend).

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.

Student Activities

CBB student activities are scheduled **every week on Wednesdays from 4 to 5pm**. They consist of:

- A computational seminar series on the first Wednesday of each month
- Town Halls approximately every 3 months [including faculty]
- Research-In-Progress (RIP) and Journal Club (JC) meetings [students only]

The most up-to-date schedule is available via a link sent to all current students and food will be provided at all non-seminar meetings.

Note that meetings will be in-person and attendance will be taken at all non-seminar meetings. You will need to email the [DGS](#) if there are meetings that you are unable to attend.

All students will present once a year after their first year (first years will present separately about their [rotation projects](#)). Please arrive on time. The DGS will typically attend the first few minutes of RIP and JC meetings to make general CBB announcements and answer any questions.

CBB Research-in-Progress (RIP) Talks

- **Required attendance:** All CBB students
- **Presenters:** Year 4+ students
- **Length:** 20 minutes + 5 minutes for feedback/questions (10 + 5 if 3 presenters are assigned to a day)
- **Format:** not fixed
- Talk titles should be sent to cbb-registrar@yale.edu 2 weeks in advance

CBB Journal Clubs (JC)

- **Required attendance:** All pre-qualification CBB students (others are strongly encouraged)
- **Presenters:** Year 2 and 3 students
- **Length:** 15 minutes + 10 minutes for discussion/questions (10 + 5 if 3 presenters are assigned to a day)
- **Format:** not fixed
- Papers should be sent to cbb-registrar@yale.edu 2 weeks in advance

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*.”

Vacation Policy

CBB currently has no formal vacation and leave policy. Different advisers have different expectations and students are expected to consult with them prior to taking time off.

Financial Support

PhD students in good academic standing receive a yearly-increasing stipend (in 2023-2024 the amount is \$40,530*), 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 \$44,530 in 2022-23).*

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 \$350 that can be used towards travel to a conference in the first year (original receipts or invoices are required for reimbursement). All students are also eligible to apply for the GSA Conference Travel Fellowship.

- * *PhD students with families are also provided an annual subsidy of \$7,500 for having a child under 18 (with an additional \$2,500 per year per any other child under 6) by the Graduate School. Enrollment must be completed every term.*
- * *As of spring 2022, there is also a Dean's Medical Leave Hardship Fund that goes up to \$3000 which may help cover serious medical conditions in addition to the standard Dean's Emergency Fund.*

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.

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.