



Yale's Integrated Graduate Program In
PHYSICAL and **ENGINEERING BIOLOGY**

Information for Graduate Students

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Acronyms

AP—Applied Physics

BBS—Biological and Biomedical Sciences

CBB—Computational Biology and Bioinformatics

DGS—Director of Graduate Studies

GTC—Graduate Teaching Center

IGPPEB—Integrated Graduate Program in Physical and Engineering Biology

IW—Integrated Workshop

MB&B—Molecular Biophysics and Biochemistry

MCDB—Molecular, Cellular and Developmental Biology

MEMS—Mechanical Engineering and Materials Science

CEE—Chemical and Environmental Engineering

BME—Biomedical Engineering

PEB—Physical and Engineering Biology, often used in place of IGPPEB

RBSI—Raymond and Beverly Sackler Institute

SDG—Sackler Discussion Group

SEAS—School of Engineering and Applied Sciences

SI—Special Investigation

TA—Teaching Assistant

YUHS—Yale University Health Services

Introduction

The IGPPEB (PEB for short) is designed to enable students to identify and tackle cutting-edge problems in the life sciences. The program's focus is on quantitative, integrated research approaches that lie at the intersection of biology, physics and engineering. Through your coursework, your interaction with faculty, postdocs and graduate students and other researchers at Yale, participation in a variety of seminars, and extensive laboratory experience, you will be prepared for a career in the sciences and capable of successfully applying physics and engineering methods and reasoning to biological problems.

PEB students enter through a home department or track (departments are organized into tracks for the first year of graduate studies within the Biological and Biomedical Sciences) and will ultimately receive their Ph.D. from that department. PEB students will receive a certificate for having completed the PEB requirements. Currently the admitting Departments/tracks for PEB are: AP, Physics, Neuroscience, CBB, BBSB, MCGD, BME, CEE, and MEMS. There are many different ways in which to meet both your home department's/track's and PEB's requirements, without significantly increasing the overall course load. The exact combination of courses you will take depends on your background and future research interests. Later in this handbook we show examples of possible course combinations for students entering PEB via different departments/tracks.

This booklet will provide you with useful information for navigating graduate school. It includes a detailed description of the PEB requirements, as well as miscellaneous information pertinent to the graduate program and to life as a graduate student at Yale.

PEB allows students to get to know and interact with faculty and students from a broad range of disciplines and backgrounds. In addition, it provides opportunities for research exchanges, and network with students from other institutions also completing an interdisciplinary training program.

If you have any questions about the PEB program, contact Dr. Dorottya Noble (Associate Director - dorottya.noble@yale.edu)

PEB Requirements and Curriculum Overview

- PEB students should complete all requirements for the Ph.D. degree within six years.
- Coursework should be completed with the first two years of graduate studies. If this cannot be done, the student should discuss the matter with PEB leadership.
- The Integrated Workshop and Methods and Logic in Interdisciplinary Research PEB courses must be taken during the first year.

The First Year - overview

During the first year, PEB students will typically take three or four courses each semester. An exciting part of the PEB curriculum is the Integrated Workshop (See PEB curriculum) in which students from different backgrounds work together on modules, co-taught by faculty, cover a broad range of PEB research areas and skills.

In addition, students will perform lab rotations or special investigations (SI) (see below). Typically, students chose the lab in which they will conduct their dissertation research by the end of the spring semester. Sometimes the need arises to do additional summer rotation(s). That is possible but requires consultation with the PEB Director, Prof. Corey O'Hern. In this case, students would join a lab at the end of the summer.

Students are expected to attend and participate in the monthly Sackler Discussion Group.

Lab Rotations and Special Investigations (SI)

The purpose of the lab rotations or SIs is to familiarize students with a variety of research labs and help them make an informed decision about which lab they want to join and conduct their dissertation research in.

Depending on the students' home track, each student will perform three lab rotations (CBB, BBSB, neuroscience, and MCGD) or one or two Special Investigations (MEMS, CEE, AP, Physics, BME). Students who remain uncertain about their choice of a laboratory will be encouraged to pursue a rotation during the summer.

You should take your rotations or SIs seriously and choose the labs carefully, keeping in mind your research interests, work habits, etc. You should also use your laboratory rotations/SIs to get to know the PI running the lab and all the lab members. This is a good way to 'test' and see how you like the lab environment in addition to the research. Many departments will require students to present their progress after each rotation via a talk. You should check your home department's requirements with respect to this (see Departmental Handbooks or contact your Director of Graduate Studies).

Teaching Assistantships (TA)

Teaching is an important part of your scientific training. Therefore, you will be required to teach during your Ph.D. You should check with your department as to the specific teaching requirement, but usually two semesters are required (see Other Departmental Handbooks). We strongly recommend looking at what Yale's Center for Scientific Teaching and the Yale Center for Teaching and Learning has to offer to help you become a better TA or if you are interested in teaching in the future.

Qualifying Exam / Admission to Candidacy

The specific format of the exam depends on your department and you should find out as soon as you can, what to expect for this exam (see Departmental Handbooks or talk to your DGS). In general, students qualify in their second year. The exam typically has both a written component and an oral component but the format does vary department to department.

Advising and Research Committee

It is important to be able to conduct research in a supportive environment. Therefore, besides your research advisor(s), you will also have a research committee. This committee will consist of your research advisor(s) plus two or three additional faculty members who, together, will be able to guide you and ensure that your progress is satisfactory.

Presenting Your Research

Being able to communicate effectively with other scientists is an important skill to have. Therefore, many departments require students to present at least once a year beyond their first or second year. You should check your home department's requirements (see Departmental Handbooks). Often, your presentation could be a research talk at Yale or a poster presentation or talk at a conference. There are many opportunities available at Yale to present your research, including the Sackler Discussion Group (SDG).

Seminars

You should attend as many seminars as possible during your graduate career (see *SDG* and *Departmental Seminars*). They are a great way to be exposed to new and different science and meet other researchers. Also, many departmental seminars feature events such as lunch or dinner with the speaker, specifically for graduate students and postdocs. Such events are great opportunities to talk to leading scientists in informal settings, so be sure to find out about these opportunities through your departmental administrative assistant.

Grades

Classes and rotations or SIs will be graded. For graduate courses, Yale uses Honors, High Pass, Pass, and Fail instead of traditional letter grades. The graduate school requirement is a High Pass average. However, you should also check your home department's requirements as some have additional requirements to remain in good standing.

PEB Curriculum

Fall Semester

MB&B 591/MCDB 591/ENAS 991/PHYS 991 Integrated Workshop (IW)

In the IW, students from a variety of academic backgrounds work together on hands-on projects and presentations that are organized into multi-week-long modules. Modules are often co-taught by PEB faculty with complimentary expertise (i.e. one from biology, one from physics or engineering, one is a theoretician and one is an experimentalist). Each module also incorporates lectures given by faculty to introduce the research topics and quantitative methods. The modules are devised so that a range of skills are acquired, and students learn from each other. To accommodate those who may not have any MATLAB experience, the course starts with a short MATLAB tutorial. The IW also serves as a way to ensure that all incoming students know each other and get to know PEB faculty and current PEB students. Examples of modules are: "Zebrafish Elongation" "Proteins" "Crowding in the Cytoplasm" "Dynamics of Chromatin".

MB&B 520, Boot Camp Biology for Physicists and Engineers (half-semester, 0.5 credit)

A half-semester intensive introduction to biological nomenclature, systems, processes and techniques for graduate students with backgrounds in non-biological fields including physics, engineering and computer science who wish to perform graduate research in the biological sciences. It will provide a basic coverage of biological nomenclature, systems, processes, and techniques to equip the student to subsequently take more advanced biological courses as desired. *This primer class is designed for students who have little or no background in biology. Many PEB students will not need to take this course.*

MB&B 635 / ENAS 518 Mathematical Methods in Biophysics (1 credit)

Applied mathematical methods for students with a biological background, including statistics and error analysis, differential equations, linear algebra, and Fourier transforms, and analysis of real data from various research groups. *This primer class is designed for students who have little or no background in math or computation. Many PEB students will not need to take this course.*

MB&B 523/ENAS 541/PHYS 523, Biological Physics (1 credit)

An introduction to the physics of many important biological phenomena, including molecular motors, protein folding, bacterial locomotion and allostery. The material and approach are positioned at the interface of the physical and biological sciences.

Spring Semester

MCDB 562/CBB 562/PHY 562/MB&B 562, Dynamical Systems in Biology (1 credit)

Advanced topics in computational biology and the techniques used to integrate knowledge from mathematics, physics, and engineering into the analysis of complex living systems as dynamical systems. Use of these methods to address key questions about the design principles of biological systems.

MB&B 517/MCDB 517/ENAS 517/PHYS 517, Methods and Logic in Interdisciplinary Research (half semester, 0.5 credit)

A half semester class introducing integrated approaches to research. Each session will be led by two faculty with complementary expertise and will discuss papers that use different approaches to the same topic (for example, physical and biological or experiment and theory). Students first meet by themselves to hammer out the details of the papers, and then with faculty.

Alternative courses that may be taken in place of MCDB 562 / PHYS 562 / MB&B 562, Dynamical Systems in Biology with permission from PEB leadership are:

- **MCDB 261: Introduction to Dynamical Systems in Biology (1 credit; with permission from the instructor)**

An introduction to quantitative methods in biology, emphasizing numerical and analytical modeling of processes in biological systems. Instruction in the use of MATLAB; writing, understanding, and solving differential equations. Topics include switches, feedback, regulatory networks, cooperativity, and signal transduction.

- **MB&B 752 /MCDB452 / CB&B752 / MCDB752 / CPSC752 / MB&B452**

Bioinformatics: Practical Application of Simulation and Data Mining (1 credit)

Bioinformatics encompasses the analysis of gene sequences, macromolecular structures, and functional genomics data on a large scale. It represents a major practical application for modern techniques in data mining and simulation. Specific topics to be covered include sequence alignment, large-scale processing, next-generation sequencing data, comparative genomics, phylogenetics, biological database design, geometric analysis of protein structure, molecular-dynamics simulation, biological networks, normalization of microarray data, mining of functional genomics data sets, and machine-learning approaches to data integration.

- **ENAS 567 Systems Biology of Cell Signaling (1 credit)**

This course designed for graduate and advanced undergraduate students is focused on systems biology approaches to the fundamental processes underlying the sensory capability of individual cells and cell-cell communication in health and disease. The course is designed to provide deep treatment of both the biological underpinnings and mathematical modeling of the complex events involved in signal transduction. As such, it can be attractive to students of biology, bioengineering, biophysics, computational biology, and applied math. The topics have been selected to represent both cutting-edge directions in systems analysis of signaling processes and exciting settings to explore, making learning complex notions more enjoyable.

- **GENE 760 01 (21023) Genomic Methods for Genetic Analysis (1 credit)**

Introduction to the analysis and interpretation of genomic datasets. The focus is on next-generation sequencing (NGS) applications including RNA-seq, ChIP-seq, and exome and whole genome sequencing. By the end of the course, each student will be able to process and analyze large-scale NGS datasets and interpret the results. This course is intended only for graduate students who are interested in applying genomic approaches in their thesis research. At a minimum, students must have basic familiarity with working in a UNIX/Linux computing environment. Prior experience with shell scripting or a scripting language such as Perl, Python, or Ruby is strongly recommended. Interested students must contact the instructor early in the fall term to discuss their prior experience and expectations for the course. Enrollment limited to twenty.

Home Department /Track PEB possible course combinations

The PEB requirements have been carefully meshed with those of the home departments/tracks to avoid substantially increasing the course load for PEB students.

NOTE:

- 1) These course combinations are suggestions, and the exact combination should be tailored to the individual student.
- 2) The courses listed here are core, required courses. You may have to take additional elective courses to satisfy the home departmental/track requirements. Make sure you check with your home department/track about their specific requirements.

Students who entered through the Combined Program in Biological and Biomedical Sciences (BBS) enter through tracks, which are often made up of several departments. For the first year, students will be part of a track. Once they join a lab at the end of the first year, they will be

associated with a department (most frequently the same as their research advisor).

Biochemistry, Quantitative Biology, Biophysics and Structural Biology / PEB

BQBS requirements: Students need to take 4 BQBS courses, one in each of the four areas: Macromolecular Biophysics, Cells and Organisms, Quantitative Biology, Critical Thinking, Structure and Biophysical Analysis. To see all possible courses, please visit <http://bbs.yale.edu/biochemistry/about/index.aspx>

Below, we show an example of the BQBS and PEB course requirements integrated. **Total course requirement:** 7, one-term courses; **Rotation requirement:** 3 rotations

Fall semester, first year

- 1) Biophysical Analysis of Macromolecular Structures and Interactions (MB&B 720)
- 2) Integrated Workshop (MB&B 591/MCDB 591/ENAS 991/PHYS 991)
- 3) Methods and Logic in Molecular Biology (MB&B 730)
- 4) Mathematical Methods in Biophysics (MB&B 635 / ENAS 518) (primer course, if needed)
- 4) Boot Camp Biology for Physicists and Engineers (MB&B 520) (primer course, if needed)

Spring semester, first year

- 1) Dynamical Systems in Biology (MCDB 562 / PHYS 562 / CBB 562)
- 2) Advanced Eukaryotic Molecular Biology (MB&B 743 / GENE 743 / MCDB 743)
- 3a) Methods and Logic in Interdisciplinary Research (ENAS 517 / MB&B517 / PHYS517) (*Half credit course, first half of semester*)

Fall semester, second year

- 1) Biological Physics (PHYS 523 / MB&B 523 / ENAS 541)

The Molecular Cellular Genetics and Development (MCGD) track is administered by the MCDB Department, in conjunction with the Department of Cell Biology and the Department of Genetics.

MCGD track requirements: In the first year of graduate study, students should complete: GENE/MB&B/MCDB 625, 'Basic Concepts of Genetic Analysis'; CBIO 602, 'Molecular Cell Biology'; MCDB/MB&B 630, 'Biochemical & Biophysical Approaches in Molecular and Cellular Biology'. **Rotation requirement:** 3 rotations.

After the first year, most students join the department of MCDB, Cell Biology, or Genetics. The departmental requirements may have additional components to the MCGD track requirement. Below, we show what students would take if they joined each of the three departments.

Commonly taken elective courses for students starting in the MCGD track include Molecular Genetics of Eukaryotes, Mechanisms of Development, Molecular Mechanisms of Disease, Genomic Methods for Genetic Analysis, Stem Cells: Biology and Application, Principles of Human Genetics, as well as advanced seminars on various topics.

MCDB requirements: that of the MCGD track plus in the second year, Advanced Graduate Seminar (MCDB 902, 903)

Cell Biology requirements (5 courses total): that of the MCGD track plus an additional seminar course, Seminar in Molecular Cell Biology (CBIO 603);

Genetics requirements (5 courses total): that of the MCGD track plus in the second year, Graduate Student Seminar GENE 675;

MCGD/MCDB/Cell Biology/Genetics/PEB

Fall semester, first year

- 1) Mathematical Methods in Biophysics (MB&B 635 / ENAS 518) (primer course, if needed)
- 2) Integrated Workshop (MB&B 591/MCDB 591/ENAS 991/PHYS 991)
- 3) Basic Concepts of Genetic Analysis (GENE 625a / MB&B 625a / MCDB 625a)
- 4) Molecular Cell Biology (MCDB 602 / MB&B 602)

First-Year Introduction to Research—Grant Writing and Scientific Communication (MCDB 900)

Spring semester, first year

- 1) Dynamical Systems in Biology (MCDB 562 / PHYS 562 / CBB 562)
- 2) Biochemical & Biophysical Approaches in Molecular and Cellular Biology (MCDB 630 / MB&B 630)
- 3a) Methods and Logic in Interdisciplinary Research (ENAS 517 / MB&B 517 / PHYS 517) (*Half credit course, first half of semester*)

First-Year Introduction to Research—Ethics: Scientific Integrity in Biomedical Research (MCDB 901)

Fall semester, second year

- Advanced Graduate Seminar (MCDB 902)**
- Seminar in Molecular Cell Biology (CBIO 603)**
- Graduate Student Seminar (GENE 675)**

Spring semester, second year

- 1) Biological Physics (PHYS 523 / MB&B 523 / ENAS 541)
- Advanced Graduate Seminar (MCDB 903)**
 - Graduate Student Seminar (GENE 675)**

Computational Biology & Bioinformatics / PEB

CBB requirements: 3 graduate courses in computational biology and bioinformatics: CBB 752b, 'Bioinformatics Simulation and Data'; CBB 740a, 'Clinical and Translational Informatics'; and either CBB 750, 'Core Topics in Biomedical Informatics' OR CBB 561 'Systems Modeling in Biology' 2 graduate courses in the biological sciences: For example, PHYS 991 / ENAS 991 / MB&B 591, 'Integrated Workshop'; 2 graduate courses in areas of informatics/quantitative areas: For example, PHYS 523a / MB&B 523 / ENAS 541, 'Biological Physics'; MCDB 561, 'Dynamical Systems in Biology'; 2 additional courses in any of the three core areas: For example, MB&B 635 / ENAS 518, 'Mathematical Methods in Biophysics'; ENAS 517 / MB&B 512 / PHYS517, 'Methods and Logic in Interdisciplinary Research'; **Total course requirement:** 9 courses; **Rotation requirement:** 3 rotations

Fall semester, first year

- 1) Boot Camp Biology for Physicists and Engineers (MB&B 520) (*Half credit course, first half of semester*) OR Mathematical Methods in Biophysics (MB&B 635 / ENAS 518) (primer courses, take 1 if needed)
- 2) Core Topics in Biomedical Informatics (CBB 750)
- 3) Integrated Workshop (MB&B 591/MCDB 591/ENAS 991/PHYS 991)

Spring semester, first year

- 1) Dynamical Systems in Biology (MCDB 562 / PHYS 562 / CBB 562)
- 2) Bioinformatics Simulation and Data (CBB 752)
- 3a) Methods and Logic in Interdisciplinary Research (ENAS 517 / MB&B 517 / PHYS 517) (*Half credit course, first half of semester*)

Fall semester, second year

- 1) Clinical and Translational Informatics (CBB 740)
- 2) Biological Physics (PHYS 523 / MB&B 523 / ENAS 541)
- 3) Integrated Workshop (MB&B 591/MCDB 591/ENAS 991/PHYS 991) – **ONLY** if did not take it during the first year because of taking Boot Camp Biology.

Applied Physics / PEB

Applied Physics course requirements: PHYS 506: Mathematical Methods of Physics OR ENAS 500: Mathematical Methods I, ENAS 850: Solid State Physics I, ENAS 851: Solid State Physics II, PHYS 502: Electromagnetic Theory I, PHYS 508: Quantum Mechanics I, PHYS 608: Quantum Mechanics II, PHYS 512: Statistical Physics I, and two Special Investigation courses. Students may be able to place out of one or more of these classes. If you wish to place out, discuss this with the Applied Physics DGS. **Total course requirement:** 10 courses; **Special Investigation (SI) requirement:** 2 SIs

Fall semester, first year

- 1) Mathematical Methods of Physics (PHYS 506)
- 2) Quantum Mechanics 1 (PHYS 508)
- 3) Integrated Workshop (MB&B 591/MCDB 591/ENAS 991/PHYS 991)
- 4a) Boot Camp Biology for Physicists and Engineers (MB&B 520a1) (*Half credit course, first half of the semester*) (primer course, if needed)

Spring semester, first year

- 1) Quantum Mechanics 2 (PHYS 608)
- 2) Statistical Mechanics 1 (PHYS 512)
- 3) Electromagnetic Theory I (PHYS 502)
- 4a) Methods and Logic in Interdisciplinary Research (ENAS 517 / MB&B 517 / PHYS517) (*Half credit course, first half of semester*)

Fall semester, second year

- 1) Solid State I (ENAS 850)

Spring semester, second year

- 1) Solid State II (ENAS 851),
- 2) Dynamical Systems in Biology (MCDB 562 / PHYS 562 / CBB 562)
- 3) Biological Physics (PHYS 523 / MB&B 523 / ENAS 541)

Physics / PEB

Physics course requirements: One elective plus five required courses; the five required courses are: PHYS 500 Advanced Classical Mechanics; 508 Quantum Mechanics I; Phys 502 Electromagnetic Theory I; PHYS 512 Statistical Physics I; PHYS 608 Quantum Mechanics II; **Total course requirement:** 6 courses; **Special Investigation (SI) requirement:** 1 SI

Fall semester, first year

- 1) Advanced Classical Mechanics (PHYS 500)
- 2) Quantum Mechanics I (PHYS 508)
- 3) Integrated Workshop (MB&B 591/MCDB 591/ENAS 991/PHYS 991)

OR

3a) Boot Camp Biology for Physicists and Engineers (MB&B 520) (*Half credit course, first half of the semester*) (primer course, if needed)

Spring semester, first year

- 1) Electromagnetic Theory I (PHYS 502)
- 2) Quantum Mechanics II (PHYS 608)
- 3) Statistical Physics I (PHYS 512)
- 4a) Methods and Logic in Interdisciplinary Research (ENAS 517 / MB&B 517 /PHYS 517) (*Half credit course, first half of the semester*)

Fall semester, second year

1) Integrated Workshop (MB&B 591/MCDB 591/ENAS 991/PHYS 991) **ONLY** if took Boot Camp Biology for Physics and Engineers course (and not the Integrated Workshop) during the Fall semester of the first year.

Spring semester, second year

- 1) Biological Physics (PHYS 523 / MB&B 523 / ENAS 541)
- 2) Dynamical Systems in Biology (PHYS 562 / MCDB 562 / CBB 562)

Biomedical Engineering/PEB

BME course requirements: To meet BME's math requirement: ENAS 505 Advanced Engineering Mathematics or ENAS 500 Mathematical Methods I; Core courses: ENAS 550 Physiological Systems; ENAS 510 Physical and Chemical Basis of Biosensing, 2 Special Investigations. A total of 10 full-credit courses need to be taken (SIs count towards this). Possible electives: ENAS 553 Immuno-Engineering; ENAS 564 Tissue Engineering (Niklason); **Total course requirement:** 8 courses; **Special Investigation (SI) requirement:** 2 SIs

Fall semester, first year

- 1) Physiological Systems (ENAS 550)
- 2) Mathematical Methods I (ENAS 500)
- 3) Integrated Workshop (MB&B 591/MCDB 591/ENAS 991/PHYS 991)
- 4a) Boot Camp Biology for Physicists and Engineers (MB&B 520) (*Half credit course, first half of semester*) (primer course, if needed)

Spring semester, first year

- 1) Dynamical Systems in Biology (MCDB 562 / PHYS 562 / CBB 562)
- 2) Biological Physics (PHYS 523 / MB&B 523 / ENAS 541)
- 3a) Methods and Logic in Interdisciplinary Research (ENAS 517 / MB&B517 / PHYS517) (*Half credit course, first half of semester*)

Fall semester, second year

- 1) Physical and Chemical Basis of Bioimaging and Biosensing (ENAS 510)

Raymond and Beverly Sackler Institute

The Raymond and Beverly Sackler Institute for Biological, Physical and Engineering Sciences brings together faculty from the Faculty of Arts and Sciences, The Yale School of Medicine and the School of Engineering and Applied Sciences enabling transformative research and teaching initiatives. The Institute promotes and supports collaborative research and networking through a variety of sponsored programs, including Graduate Fellowships for PEB students, visiting speakers, including a PEB student hosted speaker, the monthly Sackler Discussion Group (SDG), the Sackler/NSF Research Experiences for Undergraduate program, and PEB retreats and Sackler / PEB symposia. Sackler website: sackler.yale.edu

PEB Travel and Recruiting Funds

Travel: Beyond the first year, each PEB student can apply for funding of up to \$1,000 annually (June 1 – May 31), towards attending a scientific meeting or conference. Students must submit an application, at least one month in advance of the conference date, which must be approved by their PI and by the PEB leadership. The application form can be found on the PEB website: <http://peb.yale.edu/forms>

Recruiting: To help advertise and recruit for the PEB program, students, postdocs and faculty in PEB labs can apply for up to \$500 per person towards travel and registration to a conference with an official recruiting fair (max 2 people per lab per year June 1 – May 31). The application for recruiting has to be approved by PEB leadership. The application form can be found on the PEB website: <http://peb.yale.edu/forms>

An example would be the recruiting fair at the annual meeting of the Biophysical Society or of the Biomedical Engineering Society.

Future Events to Keep in Mind

Physics of Living Systems Student Research Network (PoLS SRN) annual meeting

NSF's Physics of Living Systems Student Research Network is an inter-institutional initiative to put PEB students in touch with other grad students and faculty at several institutions with comparable interdisciplinary programs. Typically, annual meetings take place in July. We will inform you of the place and date of this meeting as soon as we know (unfortunately, hosting institutes are often slow in specifying the dates!). All first year PEB students should plan on attending the PoLS SRN annual meeting. PEB first years will give posters on the Integrated Workshop modules. Beyond the first year, students can apply to attend and will be expected to present either a poster or a talk on their research. Often, these annual meetings are preceded or followed by a relevant symposium or conference. Typically, the meeting is 2-3 days. Past meetings: 2011 UCSD, 2012 Yale, 2013 Princeton, 2014 Munich, 2015 Arlington, VA (University of Maryland), 2016 Harvard, 2017 Paris, 2018 Rice.

PEB Student Invited Speaker

Each year, PEB students will have the opportunity to invite one outside speaker to Yale. If you are interested in inviting a speaker and hosting him or her, please e-mail dorottya.noble@yale.edu (Assistant Director of PEB / RBSI). The PEB student speaker for 2010-2011 was Julie Theriot, who visited in the spring, 2011 and discussed "Mechanics and Dynamics of Cell Motility". Xiaowei

Zhuang (Harvard) was another student-invited speaker who visited in the spring of 2013 and discussed “Bioimaging at the Nanoscale: Single-molecule and super-resolution fluorescence microscopy”.

Sackler Discussion Group (SDG) (with lunch!)

PEB students should plan to attend the monthly SDG meetings. The SDG is a forum that brings together researchers from biological, physical, and engineering backgrounds. Graduate students, postdocs, and new faculty present research-in-progress talks.

Meeting time: 12-1pm with lunch served at 11:45 AM. Typical locations are on Science Hill or in Engineering. PEB students receive e-mails about this seminar series, and the monthly meetings are also advertised on the PEB events page (<http://peb.yale.edu/events>).

Each year, two PEB students organize the seminar series. If you would like to be a student organizer for SDG, send an e-mail to peb@yale.edu

Additional Information

Fellowships

Obtaining external funding is important and carries much kudos in academia. There are several fellowships PEB students can apply for, each with its own eligibility criteria. You should plan to apply for those you are eligible for, and to consult with your DGS, your rotation or thesis advisor, or the PEB leadership if you need help. In addition, some departments have short workshops to you help develop your proposal. These are a great resource!

Here are some of the fellowships students frequently apply for:

- *NSF Graduate Research Fellowship Program (GRFP)*: nsfgrfp.org/
- *Ruth L. Kirschstein National Research Service Award (NRSA)*: grants.nih.gov/training/nrsa.htm
- *Hertz*:
hertzfoundation.org/dx/fellowships/award.aspx
- *Department of Defense*:
ndseg.asee.org/about_ndseg
- *Ford Foundation*:
sites.nationalacademies.org/pga/fordfellowships/
- *HHMI International Student Research Fellowship*:
hhmi.org/programs/international-student-research-fellowships

in addition, the NIH has a very extensive list of all types of funding opportunities for graduate students

(fic.nih.gov/FUNDING/NONNIH/Pages/predoctoral-graduate.aspx):

Departmental Handbooks

As you know, PEB students must fulfill both their home department and the PEB requirements. Therefore, it is important to know what your home department's requirements are. Please refer to the departmental handbooks, most of which can be obtained online. If the handbook is not online, contact your departmental administrative assistant for one.

MB&B: See departmental registrar, Nessie Stewart

MCDB: mcdب.yale.edu/sites/default/files/files/MCDBHandbook_grad%284%29.pdf

Cell Biology: https://medicine.yale.edu/cellbio/graduate/2017-18_Cell_Bio_Handbook_322771_284_5097_v6.pdf

CBB: https://cbb.yale.edu/sites/default/files/files/Computational_Biology_Handbook_2018.pdf

Genetics: https://medicine.yale.edu/genetics/graduate/2015-2016%20Handbook%20MAIN_177315_6337_v4.pdf

Neuroscience Program: <http://medicine.yale.edu/inp/academics/handbooks.aspx>

Applied physics: appliedphysics.yale.edu/forms-guides

Physics: <http://physics.yale.edu/academics/graduate-studies/graduate-student-handbook>

BME: seas.yale.edu/i-am/current-student/forms-and-guides

Departmental Seminars

Departments typically have a seminar series that meets regularly. Below are links to online calendars of various departments that list such events.

PEB: <http://peb.yale.edu/events>

MB&B: <https://mbb.yale.edu/calendar/upcoming-events/yale-and-new-haven>

MCDB: <https://mcdب.yale.edu/calendar/upcoming-events>

SEAS: <https://seas.yale.edu/news-events/events>

Physics: physics.yale.edu/calendar

Chemistry: <https://chem.yale.edu/calendar/upcoming-events>

Cell Biology: cellbiology.yale.edu/calendar.aspx

Neurobiology: <https://medicine.yale.edu/neuroscience/seminars/>

Graduate School Calendar

Graduate School of Arts and Sciences Calendar can be found at:

<https://gsas.yale.edu/academic-events>

Useful Yale websites

PEB

peb.yale.edu

Raymond & Beverly Sackler Institute for Biological, Physical and Engineering Sciences

sackler.yale.edu

Online course information

<https://courses.yale.edu/>

Secure File Transfer

This enables you to send or receive files securely.

<https://your.yale.edu/yale-link/secure-file-transfer>

Getting around Yale

You can find the bus routes of day and nighttime shuttles, find information on Zipcars, etc. You can also see, in real time, where the shuttles are.

[to.yale.edu](#)

YUHS

You can find information regarding the health services offered at Yale, including an online account to manage appointments.

[yale.edu/yhp](#)

Travel

Yale offers many savings related to traveling, including CT limo, car rental, and airport parking.

[yale.edu/ytravel](#)

Yale Center for Teaching and Learning

Similar to the Graduate Teaching Center, the center specializes in teaching how to teach across disciplines and supports people at a variety of stages in their careers. The units included in the center are the Yale Teaching Center, the Graduate Writing Center, Yale Online, among others. The center offers a variety of classes aimed to improve your teaching and mentoring skills as well as preparing future faculty. Courses on evidence-based learning, course design, the use of clickers in the classroom, etc. are available.

[ctl.yale.edu](#)

Yale Magazines / Newsletters

Yale Engineering Magazine: [seas.yale.edu/news-events/yale-engineering-magazine](#)