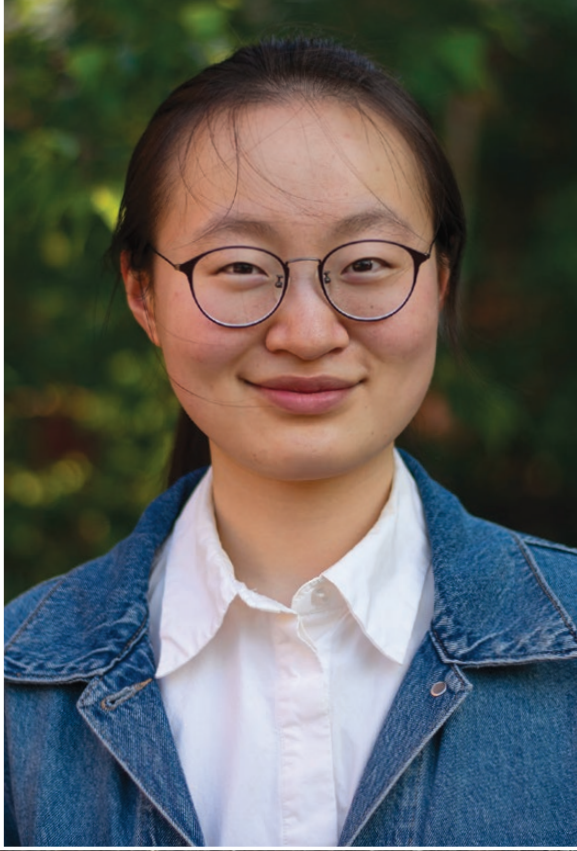

BBS Yale

How to Get a Ph.D. in the Biological & Biomedical Sciences
Yale University

Combined Program in the Biological and Biomedical Sciences at Yale University 2025–2026

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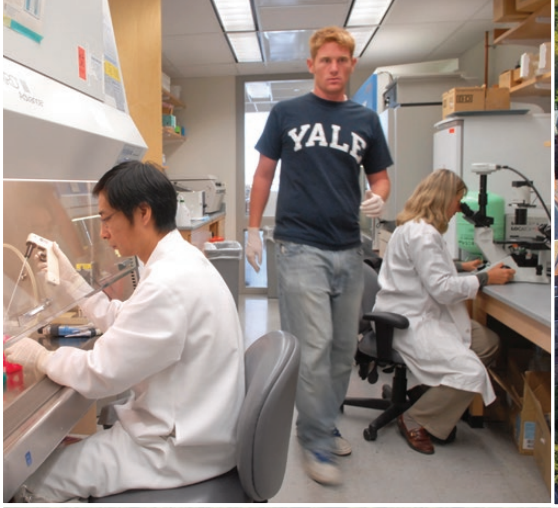
How do you get a Ph.D. at a modern research university? The very best places can be quite complex, with resources, faculty, and doctoral programs dispersed among multiple campuses, innumerable departments, and a multiplicity of institutes, centers, and other units. Can you apply to such a place in a way that doesn't limit your opportunities and your training?




Yale University


West Campus

Yes – if you apply to the Yale Combined Program in the Biological and Biomedical Sciences (BBS). BBS offers access to all of Yale's amazing array of bioscience resources. Everything the university has to offer is here in one comprehensive, interdisciplinary graduate gateway.

BBS has no boundaries, either departmental or geographical. You will have access to courses, seminars, and faculty labs in every department. Because Yale is unusual among major universities in having its main campus and medical school within walking distance of one another, you can easily participate in research activities and courses on the main University campus as well as at the world-renowned Yale School of Medicine. Moreover, Yale's new West Campus is connected to the rest of the university by non-stop shuttle service. Yale in its entirety will be yours to explore.

BBS PROGRAM

480
faculty

12
Ph.D. programs

700
students

How does BBS work? BBS is intended to enable you to explore your interests before committing to a Ph.D. program or thesis adviser. To accomplish this aim, you will apply to and spend your first year within one of eight scientific homes called Tracks:

1 Biochemistry, Quantitative Biology, Biophysics, and Structural Biology (BQBS)
2 Computational Biology and Biomedical Informatics (CBB)
3 Immunology
4 Microbiology
5 Molecular Cell Biology, Genetics & Development (MCGD)
6 Neuroscience
7 Plant Molecular Biology (PMB)
8 Translational Molecular Medicine, Pharmacology & Physiology (TMMPP)

Year 1 From within your Track you will take two to four courses per semester and conduct two to four lab rotations over the course of the year. Each Track has its own course requirements and course recommendations, though you may take elective courses from anywhere in BBS. Although each Track also has its own list of participating faculty, with the guidance of the Track Director you may rotate in any BBS labs. In the spring of your first year you will select a thesis adviser.

Year 2 At the start of the year you will leave your BBS Track and formally join one of the Ph.D. granting programs below that best aligns with your thesis lab and research project:

Cell Biology
Cellular and Molecular Physiology
Computational Biology and Biomedical Informatics
Genetics
Immunobiology
Interdepartmental Neuroscience Program
Microbiology
Molecular Biophysics and Biochemistry
Molecular, Cellular, and Developmental Biology
Pathology and Molecular Medicine
Pharmacology
Translational Biomedicine

You will complete the course requirements of your Ph.D. program, take a qualifying exam, and begin thesis research. You may also serve as a teaching assistant in a lecture or lab course.

Year 3 and beyond You will focus primarily on thesis research, including presenting your work at scientific conferences and publishing your results. You may also serve as a teaching assistant. Upon graduating you will receive a Ph.D. from the program you joined in Year 2. The median time-to-degree is 5.7 years. Yale awards diplomas only two times per year (May and December), and you may complete your training up to 8 months prior to receipt of your diploma.

Financial Support All BBS students receive a highly competitive stipend, full tuition coverage, free health insurance (including for spouses and children), and significantly discounted dental insurance. Those who win an outside award such as an NIH National Research Service Award (NRSA) or NSF fellowship also receive a stipend bonus of $4,000.

Application Process Apply to BBS via the Yale Graduate School of Arts & Sciences' application, available beginning in late August from our website or at *gsas.yale.edu/admissions*. You may apply to only 1 BBS Track, and the application deadline is **December 1**. Interviews currently occur in late January and early February.

Because each Track has its own admissions committee, and because the Track you enter will remain your scientific home throughout your first year, it is very important to apply to the Track which best matches your scientific interests. The Track name itself and the first year curriculum described in each Track's *Program of Study* are helpful indicators of which Track is the best fit. For example, the Neuroscience Track is best for those with a passion for studying neuroscence, whether from a computational, behavioral, molecular, or other approach. Likewise, the Molecular Cell Biology, Genetics and Development (MCGD) Track is ideal for those who want to address biological questions using cellular, genetics, molecular, and/or developmental approaches.

Note that faculty may participate in multiple Tracks, and faculty alone, therefore, are not the best indicator of which Track to which you should apply.

Application Requirements BBS students come from a variety of academic backgrounds and receive training at Yale in a wide array of disciplines. As a result, there are no common courses required of all BBS applicants. Visit each Track's description for Track-specific course requirements. Admissions committees will look for applicants who already have some research experience, either while as undergraduates or in a job after graduation. It is important to gain some experience prior to applying.

We do not have a minimum GPA requirement. We do not require the Graduate Record Examination (GRE) General Test, and submitted GRE scores are not included in the review of an application. Applicants for whom English is not the native language may be required to submit TOEFL or IELTS scores. When reporting scores to Yale University, please use institution code 3987. Use any department code.

For complete details about applying to the BBS Program, please visit us at *bbs.yale.edu*, or follow the QR code to the left to our site.

GRADUATE TRAINING

Although the focus of doctoral training is on developing and completing an independent research project, coursework and teaching are also integral to the training experience.

BBS Courses Each Track has its own required and recommended courses, with room for electives tailored to your interests. You will complete most of your coursework in your first year and finish your course requirements in your second year. BBS offers dozens of courses across all bioscience disciplines, and descriptions of our most recent course offerings may be downloaded from the *Ph.D. Training* section of our website.

Student Teaching An important aspect of graduate training at Yale is the acquisition of teaching skills through participation in didactic courses. These opportunities may be in lecture, laboratory, or seminar courses given at the undergraduate, graduate, or medical student level. You will participate in two semesters (or its equivalent) of teaching prior to graduating but will not teach in your first year. The Yale Poorvu Center for Teaching and Learning offers many workshops to prepare you to enter the classroom and also offers advanced teacher training for those who plan to pursue academic careers.

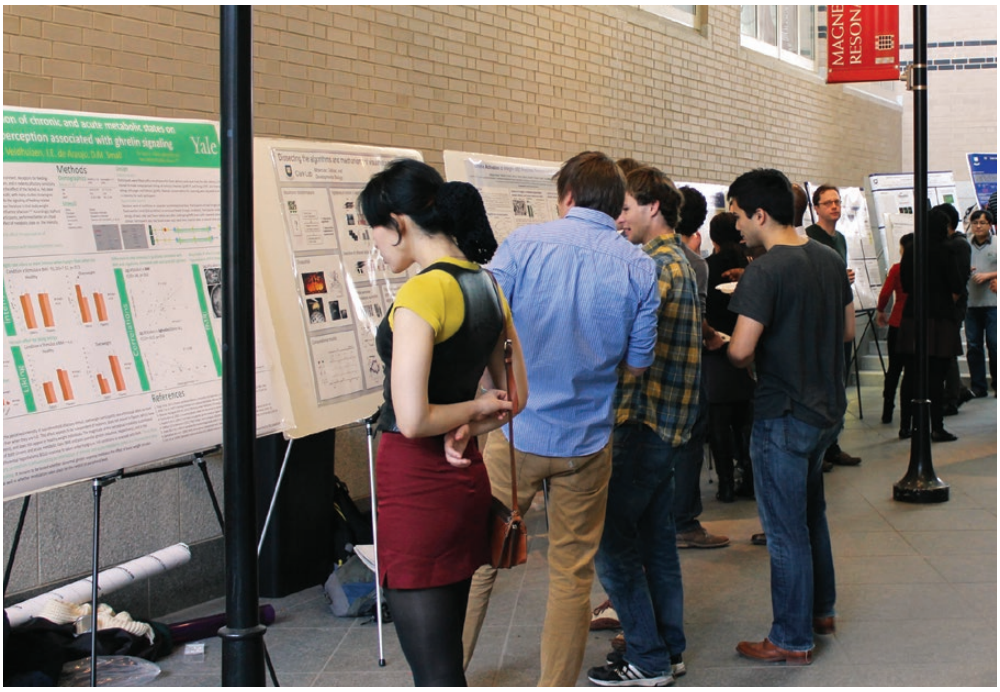
Special Programs Within BBS are several programs that offer additional, specialized training to a subset of students. Express interest in these programs when you apply to Yale.

CANCER BIOLOGY TRAINING PROGRAM Recent advances in understanding cancer, combined with unprecedented access to tumor DNA sequence data and new rational therapeutic approaches created the need for a revolution in training of Ph.D. scientists. The Yale Cancer Biology Training Program provides a unique cancer-focused training experience intended to spawn the next generation of cancer scientific leaders. Training covers the genetic and biological underpinnings of cancer, the pathway to development of new therapies based upon this knowledge, and the practical challenges in applying these new therapies in cancer clinics. Students are admitted into the program at the end of their first year of training and may be from any Track.

CELLULAR, MOLECULAR, AND QUANTITATIVE BIOLOGY PROGRAM (CMQB). The CMQB Program is designed for students in the Molecular Cell Biology, Genetics and Development Track or Biochemistry, Quantitative Biology, Biophysics, and Structural Biology Track who are interested in being trained to study cell and molecular biology from an interdisciplinary, rigorous, and quantitative perspective. The CMQB curriculum prioritizes teaching the skills to perform fundamental research at the highest level while preparing students for careers in and outside of academia. The curriculum includes a monthly research in progress series, yearly retreats, and specialized career and soft-skill seminars.

CHEMISTRY/BIOLOGY INTERFACE (CBI) Yale's CBI Training Program provides interdisciplinary training at the intersection of chemistry and biology. Special features of the CBI include interdepartmental course work and rotation schedule, a monthly in-house seminar program for

Students, faculty, and postdocs present posters for visiting applicants to the Neuroscience Track.



discussion of recent results, and an annual Chemical Biology Symposium. BBS applicants who are interested in Chemical Biology are encouraged to apply to Molecular Cell Biology, Genetics and Development; Biochemistry, Quantitative Biology, Biophysics, and Structural Biology; or Translational Molecular Medicine, Pharmacology, and Physiology.

INTEGRATED GRADUATE PROGRAM IN PHYSICAL AND ENGINEERING BIOLOGY (IGPPEB) IGPPEB trains scientists who apply quantitative reasoning and methods to analyze cutting-edge life-science questions. Innovative components of the IGPPEB include a balance of students from physical and biological backgrounds; reciprocal peer tutoring in "boot camp"-style courses that will establish a common mathematical/physical and biological language; students learning together and from each other in introductory courses ("Biological Physics", "Modeling Biological Systems", and "Integrated Workshop"); an emphasis on the importance of computational approaches via introductory and advanced classes in computation and simulation; and joint mentoring by faculty from physics, engineering, and biology backgrounds. BBS applicants to the following Tracks are eligible to join IGPPEB: Biochemistry, Quantitative Biology, Biophysics, and Structural Biology; Computational Biology and Biomedical Informatics; Molecular Cell Biology, Genetics, and Development; Neuroscience; Translational Molecular Medicine, Pharmacology, and Physiology.

MEDICAL RESEARCH SCHOLARS PROGRAM (MRSP) MRSP bridges barriers between traditional predoctoral and medical training by providing both medically oriented coursework and a mentored clinical experience to select BBS students. The coursework provides a grounding in biomedicine, and the clinical experience enables students to interact with patients to learn firsthand about disease symptoms, treatment options, and the limitations of current therapies. This combination of medical knowledge and face-to-face interaction with patients and their doctors provides a new perspective to Ph.D. students and enhances the training in basic science already provided within the BBS Program. MRSP graduates will be capable of working much more closely with physicians and physician-scientists and will be better prepared to conduct clinically relevant basic research. Students in any Track are eligible to apply.

Research Facilities Yale is among the top universities in research funding from the National Institutes of Health and the Howard Hughes Medical Institute. It also boasts hundreds of thousands of square feet of research space across three research campuses. Yale's major centralized research facilities include the Keck Foundation Biotechnology Laboratory (responsible for the synthesis and analysis of nucleic acids, proteins, and microarrays), multiple cryo-electron microscopes, numerous other imaging technologies, high performance computing facilities, and more than a dozen research centers to assist researchers with informatics, genome analysis, small molecule design, and transgenic animal preparation. All facilities are open to BBS students, and many of the centers offer hands-on training.

Research Programs and Institutes Many BBS students work on projects that reside within one of several new or existing research programs, including those highlighted below. Note that these are not Ph.D. training programs but rather are multi-million dollar interdisciplinary research endeavors involving numerous researchers, including BBS faculty, BBS students, and clinicians.

CANCER CENTER In conjunction with the Smilow Cancer Hospital, the Cancer Center seeks to study cancer from every angle and treat its various forms using cutting edge procedures and medications. Genetics, genomics, signal transduction, virology, and immunotherapy are some of the major research areas within the Center.

CANCER BIOLOGY INSTITUTE The Yale Cancer Biology Institute investigates the core biological causes of cancer. It draws faculty from both basic science and clinical departments and works closely with the Cancer Center.

PROGRAM IN CELLULAR NEUROSCIENCE, NEURODEGENERATION AND REPAIR The CNNR conducts research on neurodegenerative diseases including Alzheimer's and Parkinson's and seeks therapeutic interventions for these conditions.

WU TSAI INSTITUTE The mission of the Wu Tsai Institute is to understand human cognition. This new initiative integrates faculty from over 20 Yale departments to study the mind at the behavioral, cellular and molecular, and computational levels.

HUMAN TRANSLATIONAL IMMUNOLOGY HTI faculty investigate the immunological components of diseases such as cancer, diabetes, and asthma. The overall goal of HTI is to translate basic science discoveries into new treatments for disorders of the immune system.

MOLECULAR VIROLOGY The Molecular Virology Program studies viral biology, investigates the role of viruses in various diseases, searches for novel antiviral treatments, and offers interdisciplinary training in virology.

MICROBIAL SCIENCES INSTITUTE The Microbial Sciences Institute draws faculty and students from multiple departments to study the broad field of microbiology and especially the microbiome.

STEM CELL CENTER The Stem Cell Center investigates the development, genetics, and function of stem cells and looks for stem cell therapies for several disease states and injuries.

INSTITUTE OF BIOMOLECULAR DESIGN AND DISCOVERY The Institute of Biomolecular Design and Discovery combines faculty from the biosciences, chemistry, and engineering to explore biological questions in novel ways.

NANOBIOLOGY INSTITUTE Faculty in the Nanobiology Institute study biological systems and synthetic materials at the nanoscale level and work to design nanomaterials.

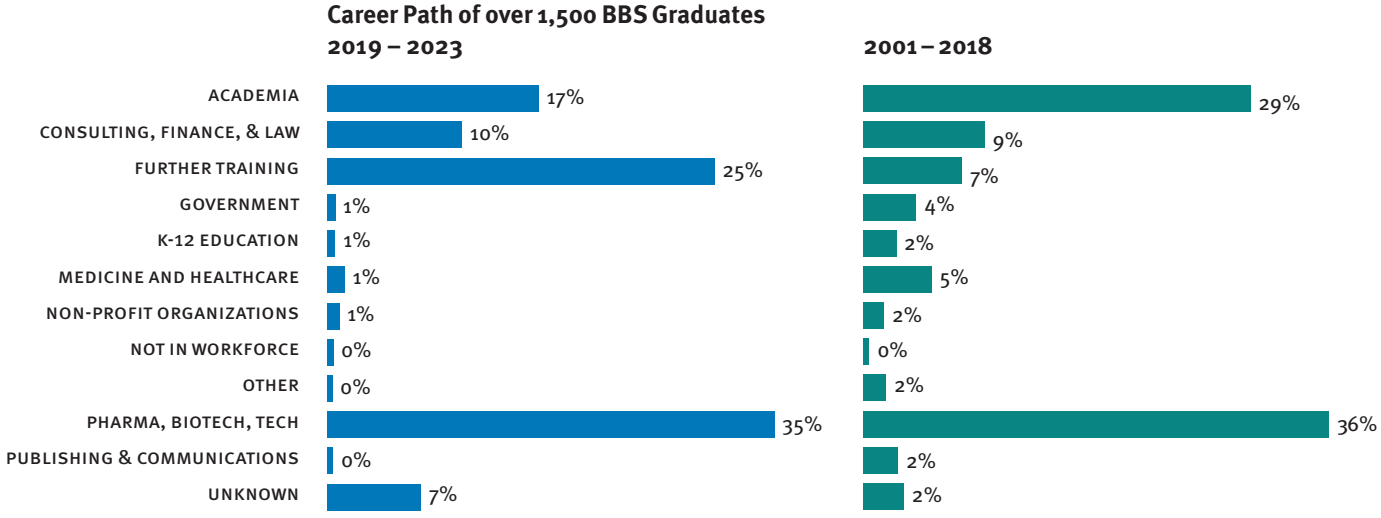
SYSTEMS BIOLOGY INSTITUTE Researchers in this institute study complex biological systems through a combination of mathematics, bioinformatics, and basic biological research.

CENTER FOR RNA SCIENCE AND MEDICINE The Yale Center for RNA Science and Medicine brings together faculty from multiple disciplines to study the basic biology of RNA and extend findings into the clinic.

Poster presentations at the Yale BBS Diversity and Inclusion Collective (YBDIC) Biomedical Research Symposium for visiting undergraduate students.

CAREER DEVELOPMENT

Career Outcomes BBS students have been extraordinarily successful in their career pursuits and enter very diverse career paths. Of the nearly 1,500 students who have graduated since 2001, career data are available for 96% of these graduates. The graphs below divide graduates into two pools:
a) recent graduates, many of whom pursue postdoctoral training upon graduation; and
b) older graduates, most of whom are now in established careers.



Yale offers innumerable opportunities to explore the many career paths available to Ph.D. scientists in the biosciences. Below are some of the main resources.

Yale Resources OFFICE OF CAREER STRATEGY The Office of Career Strategy is a full-service career center for students and alumni of the Graduate School and Yale College and offers career advising, CV and cover letter workshops, networking opportunities, career panel discussions, and job listings.

The Amistad building offers research space to several interdisciplinary research endeavors, including the Yale Stem Cell Center.

POORVU CENTER FOR TEACHING AND LEARNING The Poorvu Center for Teaching and Learning not only trains students to become excellent lecturers, it also teaches students how to create presentations, develop new courses, write exams, and control classroom dynamics. The Poorvu Center is an extraordinary resource for developing speaking and teaching skills necessary to succeed in graduate school and in future careers.

TSAI CENTER FOR INNOVATIVE THINKING AT YALE (CITY) Tsai CITY not only helps students and faculty to start up new companies, it offers bootcamps and internships in becoming entrepreneurs.

YALE CROSS CAMPUS Cross Campus is Yale's networking community for students and alumni. It offers mentorship, discussion boards, and advice for launching careers.

Student Organizations YALE SCIENCE DIPLOMATS The Yale Science Diplomats are devoted to educating the public about science issues that affect them and to encouraging scientists to become engaged in the political process. Participation in this group is an excellent way to learn about and prepare for careers in science policy.

WOMEN IN SCIENCE AT YALE (WISAY) WISAY links students with postdoctoral scholars and faculty from all science disciplines at Yale to foster career development and to establish networks with renowned women scientists.

YALE GRADUATE STUDENT CONSULTING CLUB The YGCC is a very popular club for BBS students and offers opportunities to gain real-world consulting experience to prepare graduates for careers in management consulting in the healthcare and pharmaceutical industries.

YALE JOURNAL OF BIOLOGY AND MEDICINE The *Yale Journal of Biology and Medicine* is a quarterly journal reviewed and edited by Yale faculty and students. Students interested in careers in science writing and editing will gain invaluable experience through their participation in YJBM activities.

YALE BIOTECH CLUB The Yale Biotech Club helps students bridge the gap between academia and the biotechnology sector. The group hosts career fairs, job treks, seminar series, and other initiatives to prepare students for future careers in the life sciences.

OPEN LABS AT YALE This local chapter of the multi-university Open Labs initiative offers graduate students and postdocs the opportunity to share their passion for science with children at local schools and to encourage New Haven students to consider careers in science. Open Labs is an excellent way to develop communication and teaching skills.

A new 240,000 square foot building on Science Hill is home to many BBS labs. It also has a greenhouse, quantitative biology center, physics labs, and state-of-the-art imaging technology.

DIVERSITY

BBS and Yale together welcome students from all backgrounds, and approximately 25% of incoming U.S. BBS students are from underrepresented groups. Read below for a sampling of the individuals and resources to help you thrive in graduate school and beyond.

Director of Minority Affairs The BBS Faculty Director of Minority Affairs is the program's main liaison to all university offices and resources for underrepresented minority students. The Director works very closely with the deans of the School of Medicine and Graduate School diversity offices.

Office for Graduate Student Development and Diversity The Office for Graduate Student Development and Diversity is administered through the Graduate School of Arts & Sciences and offers programs and workshops to accommodate a diverse graduate school. OGSDD also offers a Fellows Program to provide students with mentoring and outreach opportunities.

Office for Diversity, Inclusion, Community Engagement, And Equity (DICE) DICE is administered through the School of Medicine and supports both faculty and students. The Associate Dean partners with the BBS Director of Minority Affairs and also oversees the Yale BBS Diversity and Inclusion Collective described below.

Student Accessibility Services The Student Accessibility Services Office provides services to remove barriers that might impede student success in the classroom and lab. Academic accommodations include access to labs and lab equipment, classroom technologies such as notetaking and captioning tools, and approval of alternative schedules for handing in assignments or conducting research in the lab.

Cultural Centers Yale's cultural centers provide undergraduate and graduate students with formal and social meeting space to foster a sense of identity on campus. The Afro-American Center, Asian American Center, La Casa Center, and Native American Center are available year-round and often late into the evening.

Student Groups The Yale BBS Diversity and Inclusion Collective (YBDIC) engages in student recruitment, empowerment activities, and career mentoring. The Yale Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) chapter fosters community through social, mentorship, and professional development events. Women in Science At Yale (WISAY) promotes the training and career development of women and gender minorities in all science, technology, engineering, and math fields at Yale. The graduate chapter of Out in Science, Technology, Engineering, and Mathematics (OSTEM) is part of a national society dedicated to educating and fostering leadership for LGBTQ+ communities in STEM. The Graduate Student Disability Alliance (GSDA) provides a welcoming community and advocates for students with any disability.

Support for Low Income Students Yale offers application fee waivers to those who demonstrate financial hardship. Also, all admitted students receive a relocation package, free family health insurance, heavily discounted dental insurance, full tuition coverage, and a stipend that more than covers the cost of living in New Haven.

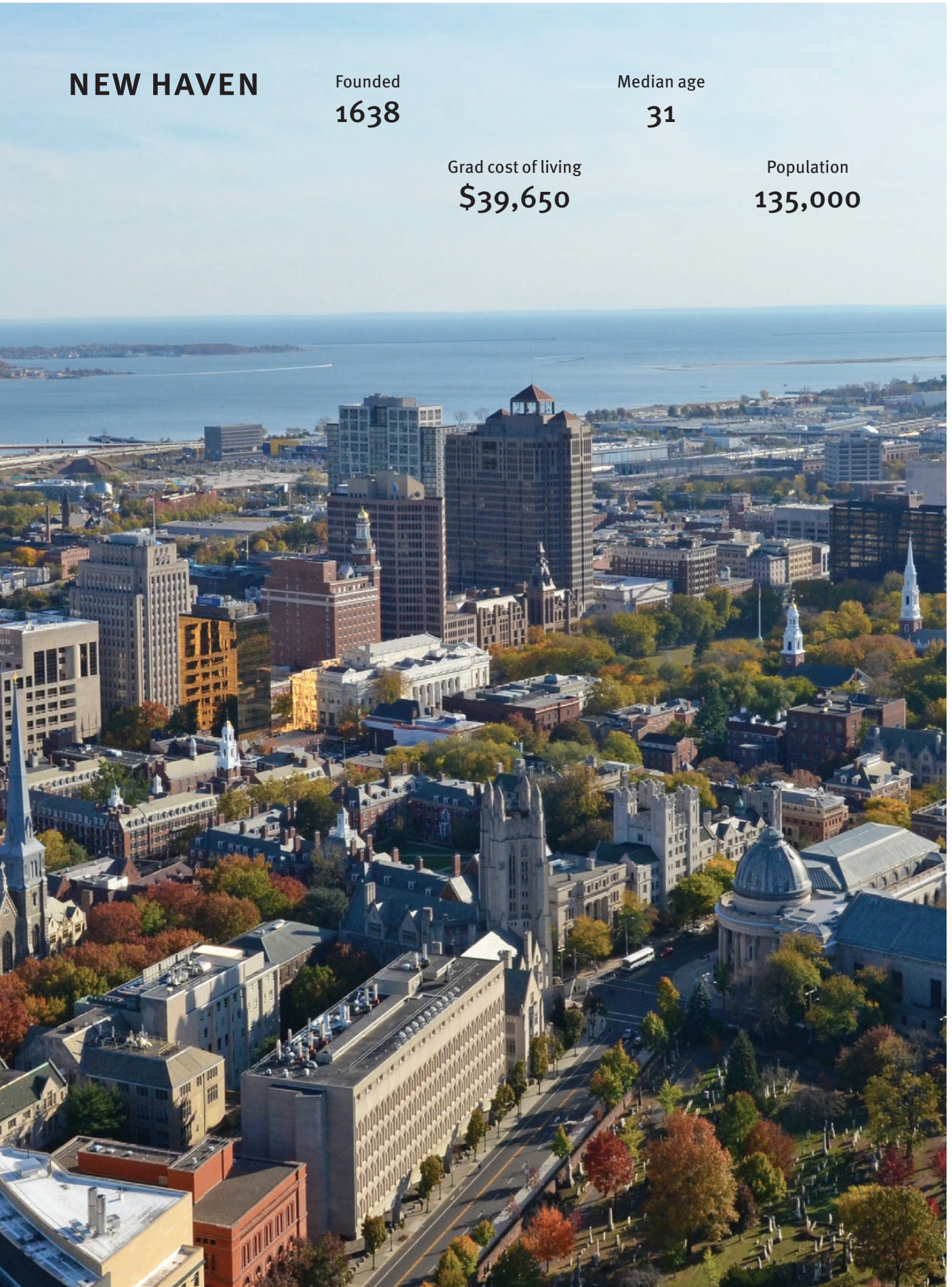
NEW HAVEN

Founded
1638

Median age
31

Grad cost of living
$39,650

Population
135,000



STUDENT LIFE

Graduate school can be a long and arduous process, and having a rich life outside the lab is important for maintaining your wellbeing. Luckily, Yale and the city of New Haven together offer innumerable opportunities for fun and enrichment. The area is Connecticut's center for the arts, music, and entertainment. Most of the events occur right on or very near campus and are thus immediately accessible. Additionally, the city has a vast assortment of restaurants and nightspots for unwinding after a day in the lab, and again, everything is close by. Lastly, recreational and outdoor activities abound. The diversity, convenience, and affordability of the many fun things to do in New Haven are what make this a great place to be a student.

Quality of life goes beyond just having fun. Relative to other metropolitan areas, the cost of renting an apartment near Yale is very reasonable. The overwhelming majority of students live within easy walking and biking distance of campus. Also, although some students own cars, Yale has a comprehensive and free shuttle system for transporting students to and from campus day and night. Right on campus is a massive health care facility open only to the Yale community, and access is free for students and their families. No one got rich from a graduate student stipend, but you will be able to afford to live in New Haven while working toward your Ph.D.

New York City is 1 1/2 hours away by car or a ~$35 roundtrip train ticket.

10 THINGS STUDENTS DO FOR FUN

1 Eat

With more amazing restaurants than you can shake a stick at, New Haven was recently named the #1 Top Foodie City in the country by Livability.com.

Yale Swing and Blues Club

2 Join a club

From the Graduate Consulting Club to the Tango Club to the Graduate and Professional Student Senate, Yale has a group to match every student's interest.

Yale Repertory Theatre

3 Catch a show

Yale and New Haven boast 4 theaters on or near campus, and they are complemented by annual festivals around the city.

4 Play a sport

Students can enjoy Yale's own golf course, tennis center, hockey/ice skating rink, sailing club, intramural fields, and nine story gymnasium.

Ingalls Rink, also known as "The Whale"

5 Hear live music

Four orchestras, countless concert series, opera, outdoor jazz, and nightclub acts provide year-round music entertainment.

Concert on the New Haven Green

6 Go on a roadtrip

Thimble Islands

NYC, Boston, the ski slopes of Vermont, and the beaches of Rhode Island and Cape Cod are all accessible for daytrips and weekend breaks from the lab.

7 Get cultured

Yale University Art Gallery

Priceless artwork, ancient artifacts, and the rarest of texts are available in Yale's world-class museums and galleries.

8 Eat again

New Haven boasts the world's best pizza and claims to be the home of the hamburger sandwich.

9 Take a ride

With miles of bike lanes and trails, New Haven is a Silver-Level Bicycle Friendly Community, designated in 2018 by the League of American Cyclists.

CitySeed farmer's market

10 Shop local

Explore the local food producers in Connecticut at one of the many farmer's markets in the area.

CAMPUS AND SURROUNDING NEIGHBORHOODS

The neighborhoods around the Yale campus are diverse in style and offerings. Some have high rise luxury apartments whereas others are comprised of free-standing homes. Some support cozy cafés while others host fine dining establishments. Virtually all are close to campus, and each is home to students and faculty.

there's an app for that

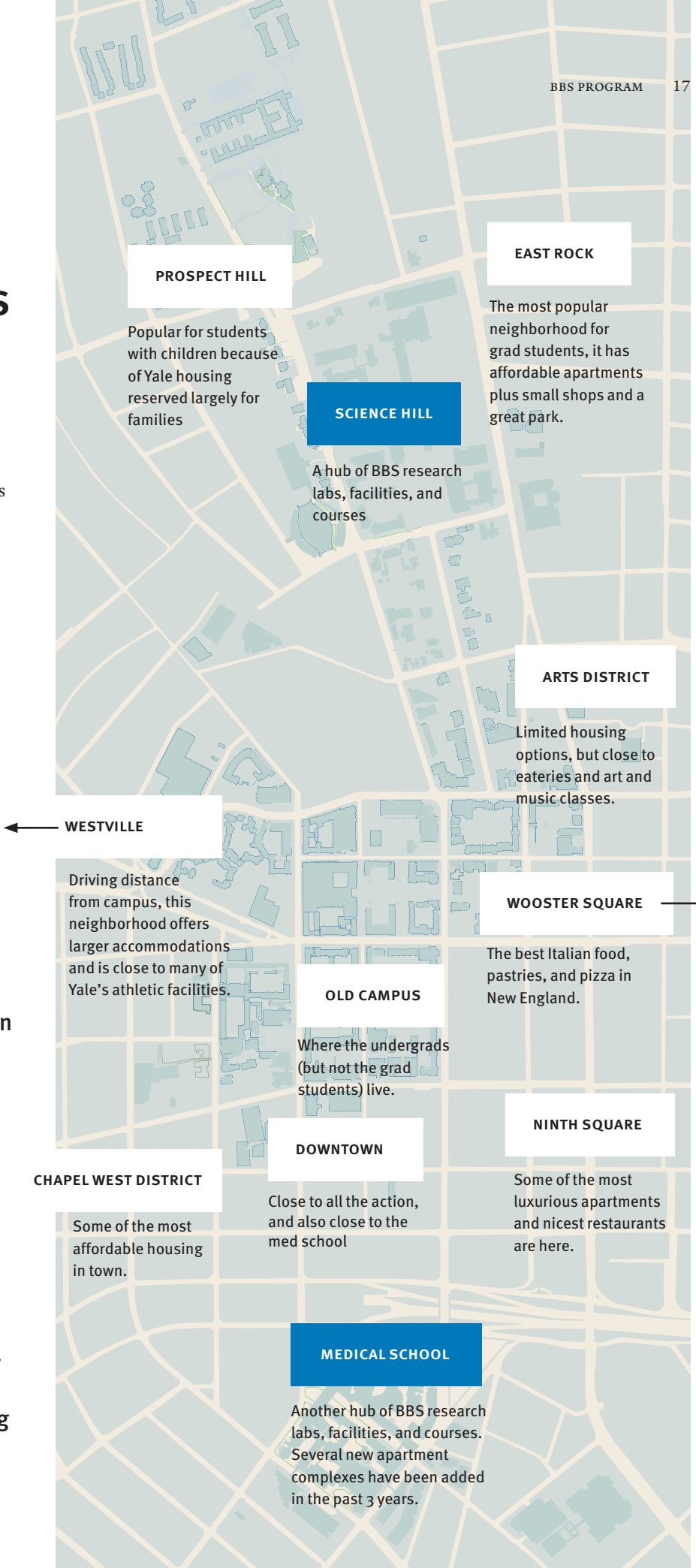
Yale shuttles are equipped with GPS devices for tracking on a computer or smart phone.

living outside of the city

There are wonderful shoreline communities and a convenient commuter rail into New Haven.

in high demand

New Haven has one of the highest apartment occupancy rate in the U.S., with many new buildings recently opening or under construction.



TRACK 1

BIOCHEMISTRY, QUANTITATIVE BIOLOGY, BIOPHYSICS AND STRUCTURAL BIOLOGY

The Biochemistry, Quantitative Biology, Biophysics and Structural Biology (BQBS) Track provides students with experimental, theoretical, and computational research training across a broad range of scales, from molecules to cells to whole organisms. Our approaches encompass a full range of modern disciplines including biochemistry and molecular biology, biophysics, chemistry, cell biology, genomics and proteomics, computational biology, and structural biology.

Recent revolutionary developments in modern biology have greatly advanced the diverse interests of our faculty. Technical advances in X-ray crystallography, cryo-electron microscopy (cryo-EM), live imaging, single molecule studies, next-generation sequencing, and mass spectrometry have led to a wealth of quantitative data for addressing long-standing biology questions. The integration of experimental data with computer modeling has stimulated productive collaborations among the disciplines of biology, chemistry, physics, and engineering. Our students will thus have broad training in experimental and quantitative skills to perform in-depth mechanistic studies of diverse biological processes.

Students in BQBS are expected to meet rigorous standards in their course work and research. Our mission is to impart the intellectual and practical skills needed to engage in biological research at the highest level. We believe this requires a combination of deep understanding of biology and chemistry and the application of quantitative methods and modeling. It is our goal to develop our students' independence, creativity and rigor, while fostering their adventurousness. These are the attributes that will propel our trainees to be future leaders in their field.

Research Areas The 105 participating faculty have research expertise in one or more of the following areas:

RESEARCH AREA	NO. OF FACULTY
Cell Cycle and Signal Transduction	50
Cytoskeleton	16
DNA Dynamics and Transcriptional Regulation	30
Drug Design, Discovery and Mechanism	28
Mechanobiology: from Cell-Cell Interactions to Tissue Mechanics	16
Membrane Biology	45
Neuroscience	24
Protein Folding, Dynamics and Degradation	29
RNA Processing and Ribonucleoprotein Machines	28
Sensory Systems from Molecules to Cells to Organisms	18
Theoretical Biology	16
Virology, Inefection and Immunity	19

Follow the QR code at left to see a list of faculty who work in each of these research areas.

Program of Study In their first year, students will participate in curricular activities designed to foster critical thinking and broad understanding of the tools and knowledge that underpin molecular and quantitative investigations of biological mechanisms. All students must take courses in four broadly defined areas: Macromolecular Biophysics (one course), Cells and Organisms (one course), Quantitative Biology (one course), and Critical Thinking (one course). Examples of core courses in these areas are shown below. In addition to formal course requirements, first-year students are required to do at least three lab rotations, and all must take our Responsible Conduct of Research course.

MACROMOLECULAR BIOPHYSICS

Biophysical Analysis of Macromolecular Structures and Interactions
Biophysics I: Structural Methods
Biophysics II: Spectroscopy

CELLS AND ORGANISMS

Advanced Eukaryotic Molecular Biology
Basic Concepts of Genetic Analysis
Molecular Cell Biology
Physiological Systems
Principles of Pharmacology
Principles of Signal Transduction

QUANTITATIVE BIOLOGY

Biological Physics
Computational Methods for Analysis & Modeling of Biological Data
Dynamical Systems in Biology
Introduction to Statistics: Life Sciences
Quantitative Approaches in Biophysics and Biochemistry

CRITICAL THINKING

Methods & Logic in Molecular Biology

BQBS Track students choose a departmental affiliation (usually the same as that of their research advisor) at the end of their first year. Each of the major participating departments has course requirements that can be satisfied in large part by courses from the four core areas mentioned above. Additional, specialized courses and electives that students take in the first and second years will enable them to fulfill the course requirements of the department they join. Track students will typically join one of the following departments: Cell Biology, Cellular & Molecular Physiology (CMP), Molecular Biophysics & Biochemistry (MB&B), Molecular, Cellular and Developmental Biology (MCDB), or Pharmacology.

KYRILLOS ABDALLAH

Biochemistry, Quantitative Biology, Biophysics, and Structural Biology Track (BQBS)

Neighborhood you live in
East Rock

Commute time from home to lab
~25 minutes

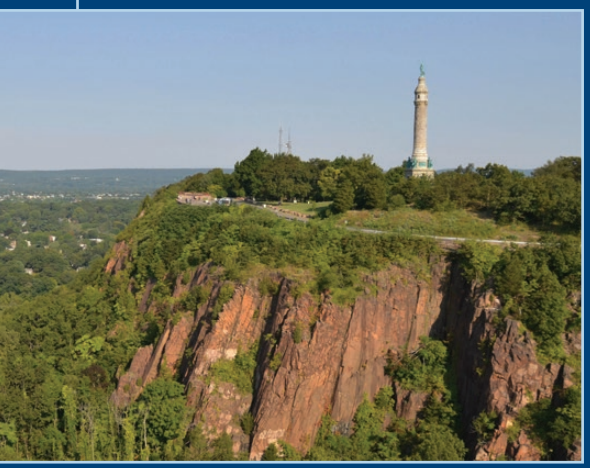
Whether you walk, bike, drive, or use the shuttle to get to lab
Shuttle or walk

Your favorite restaurant
Trinity Bar

Your favorite weekend activity
Hiking up East Rock Park!

Student groups or on campus organizations that you belong to
Nucleate, Yale Biotechnology Club, Yale Education Tutoring Initiative

Biggest surprise about New Haven or Yale
The weather is much better than everyone says!



The BQBS track in Yale's BBS Program is the perfect environment for fostering innovative and interdisciplinary thinking. With research ranging from theoretical biology to RNA biochemistry, BQBS is a wonderful place to study for folks interested in a wide array of topics. The classes, seminars, and informal discussions reflect the diversity of thought and research in the program. Coursework spans all areas of biology, from macromolecular structure and molecular biology to cell biology and organismal-level physiology. With quantitative courses such as biological physics and dynamical systems, the BQBS track encourages students to approach biology more analytically and mathematically. The laboratory rotations in BQBS are equally diverse; given that the labs at Yale cover nearly all biological topics, the only limitation during rotations is the student's intellectual curiosity. Since arriving at Yale, I have conducted research with incredibly brilliant and supportive faculty members, and I have studied alongside students who will become future leaders in their field. BQBS has allowed me to develop as a student and scientist, in a collaborative and welcoming atmosphere.

Admission Requirements Applicants are expected to have a firm foundation in the sciences. Typical BQBS students will have taken courses in biochemistry; general, organic and physical chemistry; physics; and calculus.

For further information, please contact:
BQBS Track
phone 203-432-5662
email bqbs.registrar@yale.edu
web site http://bbs.yale.edu/biochemistry/index.aspx

Science Social in the Bass building on Science Hill.

TRACK 2

COMPUTATIONAL BIOLOGY AND BIOMEDICAL INFORMATICS

The past two decades have witnessed a revolution in the biological and biomedical sciences driven by the development of technologies such as high-dimensional phenotypic profiling, next-generation sequencing, macromolecular structure determination and high-resolution imaging, wearable sensor devices, and large-scale electronic health records. These data generation technologies demand new computational analysis approaches, which, in turn, have given rise to the field of Computational Biology and Biomedical Informatics.

The Yale Computational Biology and Biomedical Informatics Track combines research training opportunities in a range of different fields within the biological and biomedical sciences, in addition to the computational sciences, statistics, and applied mathematics. The scope and balance of a student's program are highly individualized. Students in the Track develop, with the assistance of faculty advisers, a specific program of course work, independent reading, and research that gives a depth of coverage and fits their background, interests, and career goals.

Research Areas There are approximately 75 participating faculty in the Track, and representative areas of expertise among these faculty are described below.

COMPUTATIONAL GENOMICS A central problem in bioinformatics is the analysis of genomic information, culminating in the study of the human genome of an individual person (personal genomics). Research in genomic analyses includes annotating the genomes (such as coding and functional non-coding regions) through both computational and experimental approaches, dissecting gene regulation networks and signaling pathways, identifying disease-causing genes and variants (e.g., related to neuroscience), and cancer genomics.

MACROMOLECULAR STRUCTURE & HIGH-RESOLUTION IMAGING Fundamentally, the genome encodes the structures of molecules, the machines that carry out the work of the cell. Determining structures involves analysis of high-resolution imaging data from techniques such as cryo electron microscopy. Analyzing structures involves dealing with complex 3D shapes and simulating them based on physical principles. One of the grand challenges to computational biology is ab initio prediction of protein structures as well as the elucidation of structure-to-function relationships.

COMPUTATIONAL & SYSTEMS IMMUNOLOGY Computational and systems immunology involves the development and application of bioinformatics methods, mathematical models, and statistical/machine learning techniques for the study of immune system biology. Systems approaches can be used to predict how the immune system will respond to a particular perturbation such as infection or vaccination, to infer and model the molecular and cellular networks that underlie immune responses and their dynamics, and to understand and rationally

design effective immunotherapy. Computational approaches are also increasingly vital to transform the wealth of multi-omics data gathered from immune cells into biological insights. More generally, the integration of machine learning and dynamical/mechanistic modeling approaches are critical for achieving a predictive and quantitative understanding of the immune system. In addition, computational approaches are vital to empower the emerging field of synthetic immunology including the rational engineering of immune cells to serve as biosensors and therapeutic effectors.

AI MODELS AND DISTRIBUTED ANALYTICS & AI MODEL EVALUATION Repositories holding large amounts of data from patients or study participants (in particular electronic health records) need to be reconceptualized. In particular, they may require researchers to compute within their enclaves. To build and/or evaluate models across several repositories, new approaches for distributed data analysis are necessary: from model constructing and testing, to internal and external validation, methods produce results that are often indistinguishable from those that would have been obtained by centralizing all data in one place. Distributed model evaluation methods address both classification performance and model calibration and bias that can be introduced by certain models. Analyzing clinical and population health data, in addition to molecular data, is important to extract patterns, optimize workflows, and build reliable predictive models using AI.

MACHINE LEARNING TECHNIQUES & EFFICIENT ALGORITHMS Many theoretical and practical problems in the biological and biomedical sciences require unique algorithmic and computational solutions, involving machine learning, deep learning, combinatorial optimization, signal processing, and high-performance computing. For example, even simple processing of the extremely large-scale data generated by state-of-the-art genomics facilities requires considerable software and hardware development.

Program of Study The Track and the interdepartmental Ph.D. program in Computational Biology and Biomedical Informatics that most Track students join at the end of their first year prepare students for careers in academic research, education, and industry with a focus on data science and biotechnology. With the help of a faculty advisory committee, each student plans a program that includes courses, laboratory rotations, seminars, journal clubs, and independent research. Students are expected to achieve competency in three core areas: (1) computational biology and biomedical informatics; (2) biological and biomedical sciences; and (3) quantitative methods, with a particular focus on those from computer science, statistics, and applied mathematics. During the first year, all students are expected to complete a one-year-long graduate course that consists of passing three individual lab rotations over the fall and spring semesters. The courses taken to satisfy the core areas of competency may vary considerably, but a typical program will include ten courses and require 3 in core topics of computational biology and biomedical informatics. Completion of the required curriculum usually takes 3 to 4 semesters, depending in part on the prior training of the student. The training environment includes numerous seminars and speakers, journal clubs, and special-topic seminar courses. The average time to complete the Ph.D. program is approximately five years.

Admission Requirements Applicants are expected (1) to have a strong foundation in the basic sciences, such as biology, chemistry, physics, and mathematics, (2) to have training in computing/informatics, including significant computer programming experience.

For further information, please contact:
Computational Biology and Biomedical Informatics Track
e-mail cbb-registrar@yale.edu
web site http://bbs.yale.edu/computational

Members of the Computational Biology and Biomedical Informatics community celebrating the end of the academic year.

KRITI AGRAWAL

Computational Biology and Biomedical Informatics (CBB)

Neighborhood you live in
Science Park

Commute time from home to lab
25-minute walk, 10-minute bike ride

Whether you walk, bike, drive, or use the shuttle to get to lab
I typically walk to get to campus but will be buying a bike very soon! I do also take the shuttle, but I usually just hop on if it passes me on my walk rather than wait for it.

Your favorite restaurant
Lazeez Indian Cuisine

Your favorite weekend activity
I love exploring Connecticut on the weekends! I'm from California and Connecticut has a lot of unique natural beauty. I love driving to new cities and trying new restaurants!

Student groups or on campus organizations that you belong to
Yale Biotech Club, Yale Center for Engineering Innovation and Design, and Equity in the Job Search Symposium committee

Biggest surprise about New Haven or Yale
The biggest surprise was the rain. Everyone told me about the snow, but no one told me about the rain. I am used to a few times a year, but it rains a few times a month here. The rain does allow for a very beautiful and very green city.

The Computational Biology and Biomedical Informatics Track here at Yale is a very collaborative and interdisciplinary program that allows students the flexibility to find their research interests. When I first arrived at Yale, I was not sure what it was that I wanted to focus for my research. I had a background in single cell biology, but I did not know if I wanted to dive deeper in that field for my Ph.D. Given the wide array of research that the faculty work on here, I had the flexibility to explore new avenues of research in biology, math, and computer science and better understand what research really excited me. The faculty in the program have been very supportive and easy to talk to. They have been helpful in providing access to resources and opportunities to support students. The students in the program are very kind and very willing to help other students with tips about New Haven, Yale, or just research in general. We have weekly journal clubs or research in progress talks and all the students do such amazing research. I am really impressed by the research done in this program and I am excited to see what these next few years have in store!

IMMUNOLOGY

The Immunology Track is designed to prepare Ph.D. students for independent careers as leaders in immunology and related disciplines. The educational program emphasizes interdisciplinary training and collaborative and interactive research, an approach based on the idea that solving difficult problems requires the integration of individuals with common goals but differing expertise. Graduate students are diverse in their interests and backgrounds, and a welcoming culture that fosters diversity, equity, inclusion, creativity, and camaraderie is a top priority. Students in the Track are typically supported by training grants (TG) with curricula that further foster learning and career development, with the Immunology TG and Human and Translational Immunology (HTI) TG being the main programs, but others such as the Cancer Biology Training Program also support students in the Track. The curriculum and research opportunities are substantially broadened by the recent establishment of the Center for Infection and Immunity (CII; directed by Akiko Iwasaki) and Center for Systems and Engineering Immunology (CSEI; directed by John Tsang), based within the Department of Immunology, as well as by the Human and Translational Immunology Program with participating laboratories from across the medical school.

Program of Study The first year is spent taking courses (two to three each semester) and performing three laboratory rotations. Students supplement core courses in molecular and cellular immunology with additional courses selected from the wide range available in cell and developmental biology, molecular biology, microbiology, biochemistry, genetics, computational biology and bioinformatics, and molecular medicine. Required courses include intensive introductory and advanced courses covering almost all aspects of the immune system and seminar courses that focus on special topics in immunology and emphasize the methods and logic of research, how to read and critically evaluate the literature, and how to write a research proposal.

A great deal of effort is made to encourage interaction between students, faculty, and postdoctoral scholars. In addition to numerous lab and journal club meetings, the Department of Immunobiology provides a series of excellent forums for the dissemination of ideas and data. A weekly "Research in Progress" seminar series allows graduate students and postdoctoral trainees to present their latest data to the entire department for feedback and discussion. Seminar series for the Immunobiology Department, the HTI/YCIO programs, and the CSEI, bring immunologists from around the world to present their research and engage with faculty and trainees. Every year, graduate students organize the Yale Immunobiology Student Symposium and host experts in immunology and related disciplines. Finally, the Department of Immunobiology and the HTI program each hold a yearly retreat, which provides more opportunity for exchange of ideas and results and the development of a sense of community among members.

More than forty laboratories are actively involved in research in immunology. Many share immediately adjoining or nearby laboratory space in The Anlyan Center, Amistad, 100 College, and 300 George Street buildings, and three faculty are funded by the Howard Hughes Medical Institute. The Department of Immunobiology provides one of the largest integrated training programs in immunology in the country, led by a faculty with a reputation for excellence in research and dedication to mentorship, diversity, and inclusivity. The Department of Immunobiology maintains a wide variety of major equipment and benefits from cutting-edge core facilities supporting flow cytometry, genomics, genome engineering, imaging, mass cytometry, and other applications.

Research Areas Research in the Track focuses on the molecular, cellular, and genetic underpinnings of immune system function and dysfunction during development, pathogen and microbiome encounter, cancer, genetic disease, and in a variety of autoimmune and inflammatory disorders. In addition to our long-standing efforts to advance basic science research that can be applied towards human disease, we have developed a Human Translational Immunology Section to directly study human immunology and human diseases as a complementary lens to advance basic and translational immunology. Additionally, research in the Track benefits from numerous resources, collaborations, training, and synergies with centers and institutes that intersect with basic and human/translational immunology at Yale University, including the Yale Center for Immuno-Oncology, Colton Center for Autoimmunity at Yale, Microbial Sciences Institute, Institute of Biomolecular Design and Discovery, Center for Infection and Immunity, and the Center for Systems and Engineering Immunology.

Research training in our Track provides excellent access to a combination of cutting-edge methodological themes to approach immunology research questions. In particular, Track faculty excel in advancing basic and translational immunology research through the following approaches:

MOUSE MODELING Yale has a long history of seminal contributions to basic immunology through use of genetic engineering and advanced tools in mouse models. This has also extended to cutting-edge humanized mouse models and sophisticated genetically engineered mice used across the research themes.

HUMAN IMMUNOLOGY The study of human immunology and human diseases is a major strength in the Track, with a numerous laboratories working with human samples and trials to advance knowledge of the triggers, mechanisms, consequences, and treatments of human diseases, of the immune response to emerging pathogens, as well as of healthy human immune responses in various contexts.

SYSTEMS & COMPUTATIONAL IMMUNOLOGY Investigating immune responses using multi-omics approaches with single-cell resolution and integration of diverse datasets is enabling an unparalleled wealth of information about cellular and molecular interplay at a systems level. Leveraging systems, quantitative, and synthetic immunology is an emerging and exciting strength at Yale with major applications for human and translational immunology as well as basic understanding.

ADVANCED IMAGING Immune dynamics and the spatial relationship of key immune actors in tissue sites are best captured by static or live imaging. Groups in our department use and develop a variety of advanced live imaging, ultrahigh parameter spatial multiomic profiling, and cutting-edge analytical technologies to better define immune processes in their native environments.

Scientific Themes Leveraging these, the general research interests of the Immunology Track break down into seven major research themes, spanning almost all aspects of the immune system and its role in disease prevention, as described below.

LEUKOCYTE DEVELOPMENT & DIFFERENTIATION Areas of major interest include the receptors and signals that control leukocyte lineage commitment, cell maturation, cell proliferation, homing, and cell death; the establishment of the proper environments for leukocyte development; mechanisms that regulate the state of chromatin during leukocyte development and

SOFIA VELAZQUEZ

Immunology Track

Neighborhood you live in
East Rock

Commute time from home to lab
~20–30 minutes

Whether you walk, bike, drive, or use the shuttle to get to lab
I have been driving recently, since parking has been free during COVID, but otherwise I will take the bus or bike, depending on the weather.

Your favorite restaurant
Te Amo Tequila Bar and Tacos

Your favorite weekend activity
During the warmer months I love biking and hiking around New Haven and the surrounding towns of CT, but during the winter I like to stay in and have friends over to watch TV or go to Gryphons, the graduate student bar, to hang out with classmates

Student or on-campus organizations you belong to
The Immunobiology Department's Diversity, Equity, and Inclusion group, the Outreach Committee, and the Day of Immunology Planning Committee.

Biggest surprise about New Haven or Yale
The biggest surprise about Yale has been just how collaborative everyone is. I got the sense when choosing Yale that it was a welcoming environment, but as I rotated throughout labs I found Yale to excel in providing resources for people to connect and collaborate across labs, and more impressively across departments. I met and worked with so many incredible people during my rotations and feel these interactions have already started to strengthen my scientific community as I embark on my PhD research.

The program here at Yale is one of the most welcoming and scientifically rich environments I have ever been a part of. I am continuously impressed with how the students, faculty, and administrators have all come together to provide support as I transitioned into graduate school this past year. Specifically, the weekly seminars both in Human Translational Immunology and in the Immunobiology department broadly, the happy hours, and the endless department sponsored opportunities to meet with older students have really provided me an incredibly scientific network beyond my expectations. The Immunology Track faculty are constantly engaging in conversations with us as students and prove, through every interaction, how dedicated they are to the professional and scientific development of us, as graduate students. As I navigated the decision of picking a lab I felt very comfortable reaching out to students and faculty I had never interacted with previously to get their opinions and advice, and those conversations inspired confidence in my ultimate lab decision. I am excited to continue learning and exploring immunology through Yale's Immunobiology department as I believe it is an incredibly diverse and scientifically stimulating environment to perform research.

differentiation; and the mechanisms by which antibody and T cell receptor genes are assembled and diversified. After maturation, immune cells recognizing foreign antigens are activated and initiate programs of cellular differentiate into effector cells that perform critical effector functions to protect the host. After successful resolution of the response, a small fraction of T and B lymphocytes develop into long-lived memory cells that protect against reinfection.

RESPONSE TO INFECTION A major interest is the study of infectious organisms—bacterial, viral, and parasitic—and the immune response to them. A great deal of effort is directed toward understanding the way in which the immune system initiates, executes, and resolves an immune response against the pathogens and how these responses differ throughout the lifespan of an organism from early life through childhood, adulthood, and in the elderly. In addition, there are strong interests in understanding: strategies used by microbes to avoid the immune system, post-infectious syndromes, and developing novel vaccination approaches.

INFLAMMATION & HOMEOSTASIS Activation of cells of the innate immune system, including neutrophils, monocytes, macrophages, and dendritic cells trigger inflammatory responses that bridge to initiation of adaptive immune responses by lymphocytes. The receptors and signaling molecules that control inflammatory processes, mediate the balance between immune activation and potential for tissue immunopathology, and maintain tissue and organismal homeostasis are under intensive study.

CANCER IMMUNOLOGY A major focus in the program is on dissecting mechanisms of the immune response against transformed cells in the body at different tissue locations and different time scales from early to late stages of cancer. In addition to basic studies of innate and adaptive immune responses to cancer, major efforts are directed at better understanding immunomodulatory circuits that can be rewired therapeutically to trigger anti-cancer immune responses.

MICROBIOME & IMMUNOLOGY OF BARRIER TISSUES The vast landscape of microbes and microbial products that bathe our body surfaces and mucosae remains a major frontier at the interface of immunology and microbiology. Microbiome research in the Track includes efforts to define how microbial-derived products affect immune and epithelial biology and how immune cells remain poised at barriers to respond to pathogens while avoiding detrimental responses against commensals.

NEUROIMMUNOLOGY The crosstalk between immunology, the microbiome, and neurology/neuroscience is extensive with interconnected regulation of these vital biological systems having wide-ranging implications for health and disease. In addition to basic science of homeostatic interplay, areas of focus in close collaboration with colleagues in neurology also include stroke, multiple sclerosis, myasthenia gravis, neurological cancers, and related areas.

AUTOIMMUNITY, ALLERGY, & TRANSPLANTATION The immune response is tightly regulated to prevent and suppress reactivity to self and benign environmental stimuli, and the mechanisms by which these tolerance processes are maintained and cause disease when disrupted are studied in several laboratories. Additionally, immune responses to transplanted organs and ways to prevent and ameliorate graft rejection are active areas. Another major interest is in learning how specialized cells or anatomic locations, such as vascular endothelial cells or the brain, regulate and direct the immune response. Diseases being actively investigated include diabetes, multiple sclerosis, lupus, rheumatoid arthritis, allergy, celiac disease, and transplant rejection.

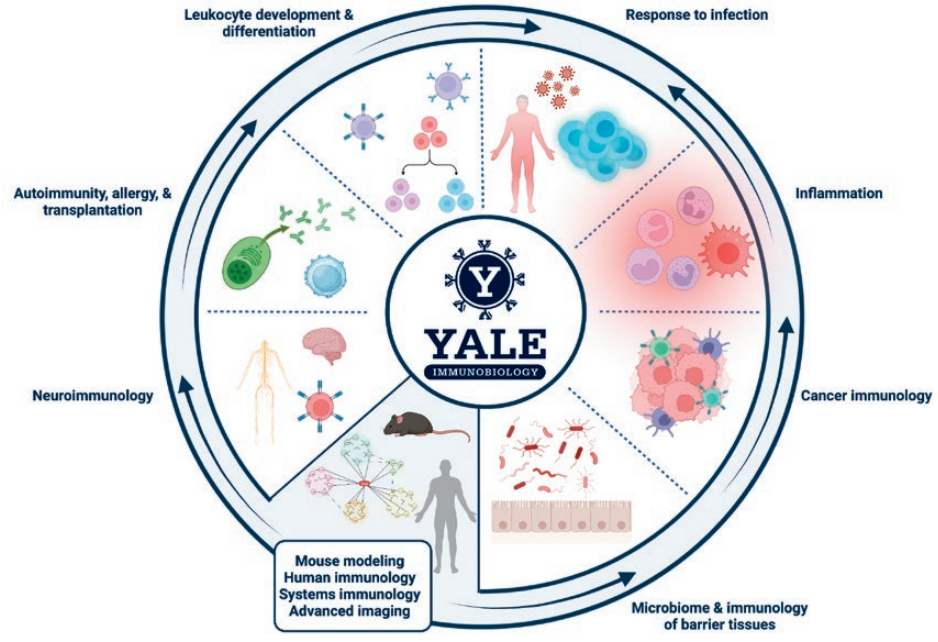
There are approximately 55 faculty in the Track, and the number who specialize in each of the approaches and themes described above are shown:

RESEARCH AREA	NO. OF FACULTY
Advanced Imaging Approaches	15
Autoimmunity, Allergy, & Transplantation	25
Cancer Immunology	23
Human Immunology	38
Inflammation & Homeostasis	39
Leukocyte Development & Differentiation	21
Microbiome & Immunology of Barrier Tissues	21
Mouse Modeling	36
Neuroimmunology	18
Response to Infection	34
Systems & Computational Immunology	26

Follow the QR code at left to see a list of faculty who work in each research area.

Admission Requirements Applicants are expected to have a firm foundation in the biological sciences. It is preferred that students have taken courses in biology, organic chemistry, biochemistry, genetics, cell biology, physics, and mathematics. Actual course requirements, however, are not fixed, and students with outstanding records in any area of the biological sciences may qualify for admission. There are no specific grade requirements for prior course work, but a strong performance in basic science courses and prior laboratory research experience are of great importance for admission.

For further information, please contact:
Immunology Track
email immuno@yale.edu
web site http://bbs.yale.edu/immunology/index.html



TRACK 4

MICROBIOLOGY

The Microbiology Track offers interdisciplinary training in the study of microorganisms and their effects on hosts and prepares students to be leaders in microbiology, virology, bacteriology, and parasitology. Studying microorganisms frequently involves molecular biology, cell biology, biophysics, biochemistry, structural biology, genomics, genetics, immunology, evolutionary biology, and ecology, and as a result, students are diverse in interests and backgrounds. The faculty are from the Department of Microbial Pathogenesis, Microbial Science Institute, and multiple departments in the Schools of Medicine, Public Health, and Arts & Sciences. Fostering diversity, equity, inclusion, creativity, critical thinking, independence, and collaboration are top priorities of the Track.

Research Areas Research focuses on the biology and pathogenesis of microorganisms, including viruses, bacteria, and parasites. Advanced and specialized facilities (for the bio-containment of infectious agents, rearing and studying insect vectors, and high-resolution imaging), infrastructure for translational research, and extensive collaborations support this research.

VIRUSES Research areas include the pathogenesis of human and animal viruses; host antiviral defense mechanisms; viral replication and cellular transformation; assembly and entry of viruses into new cells; bacteriophages; emerging viral infections; viral genomics and evolution; and the development of novel antiviral therapeutics.

BACTERIA Topics include bacterial pathogenesis; secretion and effector systems; signal transduction networks; cell morphology; manipulation of host physiology and innate immune responses; and how the microbiome impacts infection, drug metabolism, and diseases.

PARASITES Researchers study a variety of eukaryotic parasites including parasitic fungi, intracellular protozoa, and helminth worms. Current interests include strategies for cellular entry and immune evasion; transcription and RNA processing in protozoa; and parasite-vector interactions.

MOLECULAR GENETICS Research topics include DNA recombination and repair; structure and enzymatic function of nucleic acids and proteins; molecular biology of ion movement across membranes; and mechanisms of cell differentiation and cell cycle progression.

IMMUNOLOGY & HOST RESPONSE Areas include the role of cytokines in the host response to infection; mechanisms of pathogen detection and elimination by innate immune detection and effector systems; translational research studying adaptive immune responses in humans during viral infections; and single-cell genomic and bioinformatic understanding of viral-host interactions and adaptive immune responses.

MICROBIOME The microbiota (the collection of bacteria, archaea, eukaryotes, and viruses that live in or on a host organism) impacts many aspects of human health. Track faculty explore these relationships using a wide range of systems and tools.

There are approximately 55 faculty in the Microbiology Track, whose research expertise encompasses one or more of the research areas described. The approximate number in each area are shown:

RESEARCH AREA	NO. OF FACULTY
Bacteria	17
Immunology & Host Response	26
Microbiome	20
Molecular Genetics	19
Parasites	7
Viruses	25

Visit the QR code at left to see a list of faculty who specialize in each area.

Program of Study With guidance from faculty and peer mentors, students design their own curriculum, lab rotations, and thesis committee to develop fundamental knowledge in microbiology and training in independent hypothesis-driven research. During the first two years, students take at least four courses, including three microbiology-related courses involving bacterial pathogenesis, molecular biology of animal viruses, biology of the immune system, molecular mechanism of disease, molecular cell biology, system cell biology, illuminating cell function, and genomic methods. At least one of these courses will be in bacterial pathogenesis or virology. Additional required courses include microbiology seminars, research in progress, seminal papers in microbiology, and responsible conduct of research. Optional courses can be in biochemistry, molecular biology, immunology, genetics, genomics, infectious diseases, ecology, evolution, epidemiology, statistics, bioinformatics, and computational biology.

First year students take four to six courses and conduct three lab rotations. Second year students complete course requirements, take a qualifying exam, and begin thesis research. Students build community through Research in Progress seminars given by students and postdocs, Microbiology Seminars by distinguished investigators, networking hours, peer mentoring, and an annual Microbiology Retreat.

Admission Requirements Successful applicants will have completed undergraduate coursework in biology, chemistry at least through organic chemistry, physics, and calculus.

For further information, please contact:
Jennifer Atchley, Registrar
Microbiology Track
phone 203-737-1087
email jennifer.atchley@yale.edu
web site http://bbs.yale.edu/microbiology/index.aspx

AFEEZ SODEINDE

Microbiology Track

Neighborhood you live in
East Rock

Commute time from home to lab
15–20 minutes

Whether you walk, bike, drive, or use the shuttle to get to lab
Take the shuttle

Your favorite restaurant
Sitar Indian cuisine

Your favorite weekend activity
Playing Soccer or Squash

Student or on-campus organizations you belong to
Graduate intramural soccer league

Biggest surprise about New Haven or Yale
The pizza restaurants lived up to their reputation.

The wide range of research areas covered by the Microbiology Track faculty was ideal for my broad interests. I explored different research areas, studied exciting topics, and discovered previously unfamiliar fields during my rotations. The flexibility in the Track's curriculum also allowed me to prioritize topics relevant to my goals. I have enjoyed positive interactions with students and faculty throughout my classes, rotation, the Research in Progress Talks, and Microbiology Graduate Seminar Series. Initiating conversations with distinguished scientists in the department and advanced graduate students has also been straightforward throughout these events. Members of Microbiology Track have genuine interests in helping each other succeed. I am convinced that the thorough training provided by the Track and the support from department members will facilitate my development as a scientist.

TRACK 5

MOLECULAR CELL BIOLOGY, GENETICS AND DEVELOPMENT

The mission of the Molecular Cell Biology, Genetics and Development Track is to educate and train students to make paradigm-shifting discoveries in a diverse range of disciplines, including molecular biology, cell biology, genomics and quantitative biology, stem cells and developmental biology, cancer biology, and human disease modeling. Our program emphasizes interdisciplinary training and collaborative research using cutting-edge molecular technologies and experimental systems to address fundamental and innovative biological questions using a range of approaches, from super-resolution imaging to genomic and proteomic analyses. With over 125 faculty participating as trainers in our program, this Track provides a breadth of options to explore, while also creating a challenging intellectual environment that encourages students to take innovative, interdisciplinary approaches to the study of fundamental questions in biology.

Our newly revised curriculum empowers students by providing individual guidance in an intimate environment alongside vast opportunities for training in all aspects of scientific research. We develop students to be independent, imaginative and careful scientists, preparing our graduates to be the next generation of molecular cell biologists, geneticists, and developmental biologists in a broad array of science-related careers.

Research Areas CELL BIOLOGY Many researchers in the MCGD Track focus on the cell as the fundamental unit of life, studying the structure and organization of cellular components including organelles, and investigating both basic and specialized physiological properties, metabolic processes, and environmental interactions.

CHEMICAL BIOLOGY A number of MCGD faculty seek to understand the chemistry that underlies biological processes, utilizing chemistry, biology and physics. Molecular compounds are used as tools to explore and modify existing biological processes, including catalytic RNAs, engineering new proteins, RNA and DNA enzymes, the enzymology of homologous recombination, exploring signal transduction pathways, and the evolution of metabolic pathways.

DEVELOPMENT Faculty in MCGD study many aspects of development, including pattern formation, oogenesis, nervous system development, bone formation, cell migration, and many additional aspects of embryogenesis. Experimental systems include Arabidopsis, C. elegans, Drosophila, mouse, Xenopus, and zebrafish, among others.

EPIGENETICS Study in epigenetics investigates how extra-genic information, such as DNA methylation or histone modification, is established and functions to control gene expression in a wide variety of cell types and processes. MCGD faculty in particular study epigenetic mechanisms in many systems, including stem cells, early embryogenesis, neurons, and limb development, among others.

EVOLUTIONARY BIOLOGY Several MCGD faculty focus on evolutionary mechanisms in their research in order to understand how these processes drive and shape the genetic composition and phenotype of many different organisms.

GENETICS/GENOMICS Many MCGD faculty employ cutting edge whole genome sequencing and genome editing technologies, together with new bioinformatics tools, to read, edit and analyze genomes of diverse organisms. Many labs use these cutting-edge technologies to study how genetic sequence and variation underlie basic cellular and developmental processes, genetic diseases, and program new cellular functions.

HUMAN DISEASE A variety of methods are being used by MCGD faculty to study the genetic and molecular basis of human diseases, including phenylketonuria, diabetes, cancer, polycystic kidney disease, hypertension, vascular disease, aging, psychiatric illnesses, and Werner's syndrome.

IMAGING (SUPER-RESOLUTION) Seeing is believing — recent and significant advances in microscopy allow visualization of cellular and molecular events at unprecedented resolution. Many MCGD faculty employ these techniques to investigate diverse molecular pathways and cellular components and functions, often in vivo and over extended periods of time.

MOLECULAR MECHANISMS Many MCGD faculty focus on deciphering the biogenesis, function, and interaction of key biomolecules — DNA, RNA, lipids and proteins — that underlie a wide diversity of cellular and physiological processes.

NEUROBIOLOGY A subset of MCGD Track faculty investigate diverse neurobiological phenomena, including synaptic structure and function, membrane traffic, axon guidance, ion channel biophysics, receptors and signal transduction, learning and memory, and developmental neurobiology.

NUCLEAR DYNAMICS Nuclear Dynamics refers to the structural and three-dimensional organization and response of the genome in the nucleus, as well as the other proteins and macromolecules that regulate this organization, and how this impacts gene expression, cell division, and other important cellular processes.

PROTEOMICS Proteins are much more complex and molecularly diverse than are DNA and RNA, especially between cell types, and therefore present a greater challenge to study. MCGD faculty that participate in the large-scale and systematic study of protein structures and functions focus on a diversity of biological problems in prokaryotic and eukaryotic systems.

QUANTITATIVE/SYSTEMS BIOLOGY Precise and comprehensive quantitation of complex biological processes or systems requires extensive computational and mathematical modeling. Many MCGD faculty have a significant quantitative and/or systems-level component to their research, and both use and develop such tools to investigate these processes at deeper and wider resolution than permitted by qualitative approaches.

SYNTHETIC BIOLOGY A subset of MCGD Track faculty are conducting research in synthetic biology, or the engineering of biology. This emerging field is complementary to systems biology and seeks to design and construct new biological systems or re-design existing biological systems to better understand and engineer biological systems spanning prokaryotes and eukaryotes.

REGENERATIVE BIOLOGY/STEM CELLS Stem cells are the fundamental unit of regeneration and reprogramming of cellular fate, key events that govern development, homeostasis, health and successful implementation of therapies for human disease. Many MCGD faculty study the formation, plasticity and environmental factors that influence stem cell fate and function, and the organismal regenerative response.

JOANNE VILLAGRANA

Molecular Cell Biology, Genetics and Development Track (MCGD)

Neighborhood you live in
The heart of downtown New Haven

Commute time from home to lab
About 15 minutes

Whether you walk, bike, drive, or use the shuttle to get to lab
Walk

Your favorite restaurant
Steamed and Olives & Oil

Your favorite weekend activity
I love taking long walks to the East Rock or going hiking during the weekend with my dog.

Student or on-campus organizations you belong to
Graduate Lead Mentor for undergraduate STEM majors, member of Yale SACNAS, member of the 1st year Graduate Student Development & Diversity Transitions Program

Biggest surprise about New Haven or Yale
The diversity in cuisine is amazing!

Olives & Oil restaurant

The MCGD track has been extremely supportive during my first year at Yale. The number of resources for graduate students within MCGD and the BBS program has been overwhelming! I love how the faculty genuinely care and offer their assistance as we navigate courses, rotations, creating a healthy work-life balance, and choosing our thesis advisors. In addition to MCGD having phenomenal administrative staff, the faculty are determined to provide a strong foundation in molecular cell biology and genetics by introducing us to the latest research and techniques in our core courses. I am excited to continue my graduate studies here at Yale and feel confident the administration, faculty, and my peers will continue to guide me through my PhD journey.

RNA BIOLOGY RNA in all its many forms acts as a key mediator of genetic information and gene regulation, from messenger RNAs to the many structural and regulatory small and large noncoding RNAs. MCGD faculty study many aspects of RNA biology, from its synthesis and regulation, to its function in diverse cellular properties.

SIGNAL TRANSDUCTION Cells receive external cues and signals from many different molecular sources, both nearby and far away. This information must be integrated accurately for the cell to achieve an appropriate and beneficial outcome. Many MCGD faculty strive to understand how signal transduction regulates cellular processes, including cell proliferation, cell survival, differentiation, fate determination, and cell movement.

There are approximately 125 faculty in the MCGD Track, and their research expertise encompasses one or more of the research areas described. The approximate number in each area are shown:

RESEARCH AREA	NO. OF FACULTY
Cell Biology	73
Chemical Biology	17
Development	49
Epigenetics	31
Evolutionary Biology	16
Genetics, Genomics and Proteomics	1
Genetics/Genomics	79
Human Disease	67
Imaging(Super-resolution)	30
Molecular Mechanisms	86
Neurobiology	28
Nuclear Dynamics	15
Proteomics	13
Quantitative/Systems Biology	34
Regenerative Biology/Stem Cells	26
RNA Biology	25
Signal Transduction	35
Synthetic Biology	7

Visit the QR code at left to see a list of faculty with expertise in each research area.

Program of Study The educational goals of the Track are two-fold: (1) to provide students with a solid foundation in genetics and cellular, molecular, and quantitative biology, and (2) to provide flexibility for students to pursue individual interests. To achieve these goals, students are expected to complete the following core curriculum in the first year: *Molecular Cell Biology, Basic Concepts of Genetics Analysis*, and *Biochemical and Biophysical Approaches in Molecular and Cellular Biology*. Students with a strong background in a core area may place out of the requirement. Students also take a course in the Responsible Conduct of Research.

Finally, students choose elective courses from the dozens that are offered by the BBS Program. Students commonly take five or six courses within the first three semesters of graduate study.

The ideal applicants to MCGD are those who are keenly interested in learning how to study life science questions from a molecular, cellular, genetics, and/or developmental biological perspective.

Admission Requirements Successful applicants will have completed undergraduate coursework in biology, chemistry at least through organic chemistry, physics, and calculus.

For further information, please contact:
MCGD Track
email bbs.mcgd@yale.edu
web site http://bbs.yale.edu/moleculartcell/index.aspx

NEUROSCIENCE

The scientific interests of the Neuroscience Track faculty at Yale represent the full range of the broad and rapidly growing field of neuroscience. Leaders in areas ranging from the genetic and structural analysis of single-membrane channels to the functional characterization of the neocortex are represented in a diverse group of outstanding scientists. In many research areas groups of faculty with different backgrounds apply complementary technologies to similar problems. The long and productive history of multidisciplinary collaboration between basic and applied sciences has also made Yale a leader in clinically relevant neuroscience. The neuroscience faculty members command more than half the university's biomedical research budget and occupy more than 60,000 square feet of well-equipped laboratory space.

The interdisciplinary research programs of Yale neuroscience faculty are central to the Neuroscience Track. The primary purpose of the Track is to provide students with maximum diversity and depth in the most important areas of neuroscience research. The Track draws on the knowledge and expertise of more than 135 faculty members, representing over twenty departments in both the Faculty of Arts and Sciences and the School of Medicine, ranging from Psychiatry to Pharmacology and from Cell Biology to Biomedical Engineering.

The Neuroscience Track seeks to produce neuroscientists with both specialized knowledge and a broad-based understanding of the discipline. A Ph.D. degree in Neuroscience is offered by the university-wide Interdepartmental Neuroscience Program (INP), a unified graduate program founded in 1986 and jointly administered by all the participating departments of the neuroscience community at Yale.

The first-year student curriculum provides comprehensive coursework necessary to pursue the Ph.D. degree.

Research Areas There are approximately 145 faculty in the Neuroscience Track, and their research interests encompass one or more of the areas listed below:

RESEARCH AREA	NO. OF FACULTY
Axon Guidance	11
Behavioral and Systems	50
Cognitive/Learning and Memory	41
Computational Neuroscience/ Modeling	32
Development	43
Drug Abuse	18
Imaging(Super-resolution)	2
Molecular/Cellular Neuroscience (includes signaling)	68
Neural Disorders	56
Neuroimaging	42
Neuroimmunology	7
Neuropharmacology	26
Neurophysiology	39
Sensory Systems	39

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Neuroscience Track

Neighborhood you live in
Downtown, 9th square

Commute time from home to lab
It takes about 5 minutes by bike and 10 minutes if I walk.

Whether you walk, bike, drive, or use the shuttle to get to lab
I mostly bike to campus.

Your favorite restaurant
House of Naan

Your favorite weekend activity
I really enjoy the Amtrak route to Boston, great views of the coast.

Student or on-campus organizations you belong to
I am a founder member of the Diversity, Equity and Inclusion committee of the Neuroscience Department.

Biggest surprise about New Haven or Yale
It is too windy in New Haven.

The Neuroscience Track at Yale has offered me the most intellectual and sincere community during my time in New Haven. I am surrounded by brilliant people from diverse backgrounds, unified in the goal of building a stronger scientific environment. We immensely value equity & inclusion in this community and welcome anybody who brings a strong sense of commitment to the same values. Importantly, we care for and support each other amidst our hardships or happiest moments. The Neuroscience Track provides a wide range of academic resources such as well-advised rotations for finding a home lab, an interdepartmental collaborative research structure, and cutting-edge technologies to study different aspects of neuroscience from biological & cellular functions of neurons to imaging and computational modeling of neural circuits. In addition, the Track prioritizes community-building programming, such as the peer mentoring program, countless happy hours, student research talks, and weekly seminars within Yale and across institutions enabling us to network. It is a privilege to perform research with pioneers of the field, including both students and faculty, which the Track at Yale brings together. I cannot wait to see the accomplished and advanced scientists that my peers and I will become in this Track and how we will contribute numerous scientific discoveries to the field of neuroscience.

Follow the QR code at left to see which faculty conduct research in each research area.

Program of Study Each student entering the Neuroscience Track is assigned an advisory committee, which is responsible for guiding the student's course of study and for monitoring progress. The advisory committee may be subsequently modified to include faculty with expertise in the student's emerging area of interest. Although each student's precise course requirements are set individually to take account of background and educational goals, the course of study is based upon a model curriculum designed to ensure broad competence in modern neuroscience. The core curriculum comprises five courses (1) *Principles of Neuroscience* (2) *Foundations of Cellular and Molecular Neuroscience* (3) *Foundations of Systems Neuroscience* (4) *Bioethics in Neuroscience* (5) A course in quantitative methods selected based on the student's prior experience. Students must also complete at least two additional elective courses from the broad list of more advanced neuroscience courses and can take as electives any course listed in the graduate school handbook.

Each student is required to complete two lab rotations by the end of the first year. By the end of the second year students are required to pass a qualifying examination. Under the guidance of the qualifying examination committee, students study selected literature from four specialized areas of neuroscience. Following study sessions with each member of the committee, the student will complete a written examination based on the readings. This is followed by an oral examination with the members of the committee. In the third year, a thesis committee is formed comprising the thesis adviser and three other faculty members whose research interests are germane to the student's project. Upon successful completion of the qualifying examination and the submission of an approved dissertation prospectus, students are admitted to candidacy for the Ph.D. degree. This stage of the program involves independent study, research, and preparation of the dissertation in consultation with the thesis committee.

The Interdepartmental Neuroscience Program has an active seminar series which hosts national and international leaders of the neuroscience community. The numerous seminars provide students with the opportunity to interact on a one-to-one basis with visiting neuroscientists in an informal setting. To maintain regular interaction between members of the student body, Neuroscience students participate in the regular "Student Research Talks" series. At these seminars students give informal presentations of their research-in-progress. This provides graduate students an opportunity to have their work evaluated by their peers and faculty. In addition, student-directed journal clubs bring graduate students in Neuroscience together to discuss current papers in the field. Members meet on a biweekly basis and take turns leading the discussions. Participants choose topics and papers of interest to them. These journal clubs are excellent opportunities to practice presenting papers in a congenial and collegial atmosphere, to keep apprised of neuroscience research, and to maintain contact with fellow students, events, and research within the expansive Yale neuroscience community.

Admission Requirements Successful applicants will have completed undergraduate coursework in biology, chemistry at least through organic chemistry, physics, and calculus.

For further information, please contact:
Neuroscience Track
email bbs.neuro@yale.edu
web site http://bbs.yale.edu/neuroscience/index.aspx

PLANT MOLECULAR BIOLOGY

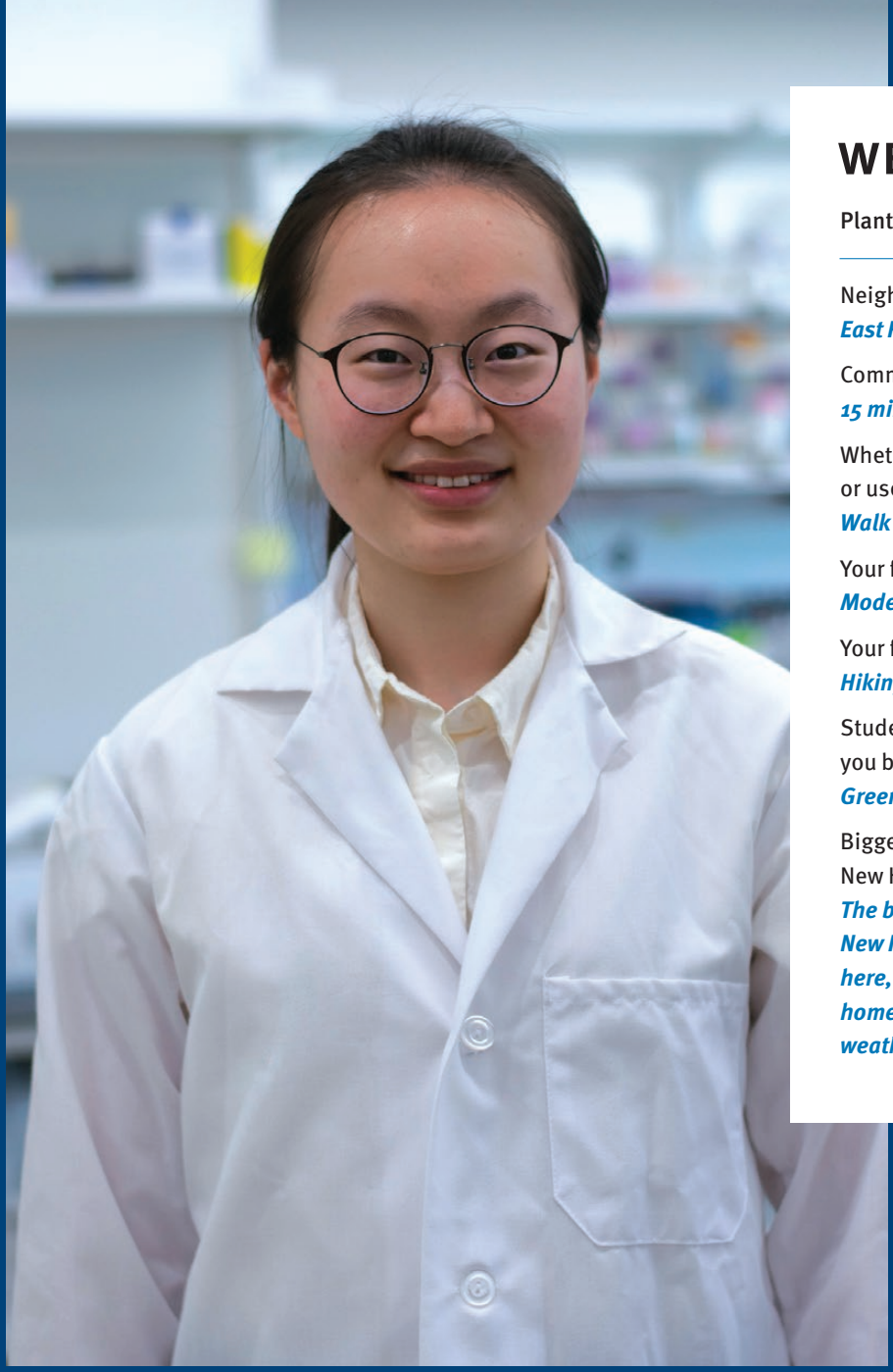
The Plant Molecular Biology (PMB) Track offers a unique interdisciplinary opportunity for graduate students with specialized interests in the plant sciences to engage in research and scholarship in the context of a broad education in all modern areas of biology. PMB students undertake an individually tailored program of study, combining coursework and training in plant biology with exposure to genomic, quantitative, biochemical, genetic, cell biological and other approaches. Our aim is to develop the future leaders in plant biology. By engaging in a robust interdisciplinary training program, we expect our graduate students to be well positioned to develop solutions to address critical agricultural, industrial, energy, and medical needs in response to a changing climate.

Graduate students in the Plant Molecular Biology Track have access to outstanding facilities and resources, including the Marsh Botanical Garden, extensive greenhouse and controlled growth chamber spaces, and the Peabody Museum of Natural History. Core facilities, including the Center for Cell Imaging and the Center for Genomics and Proteomics, provide instruction and technical support for interested students.

Program of Study Plants provide us with renewable sources of nutrition, shelter, biofuel and chemical feedstocks, and medicines, as well as shape our environment. One of the goals of the PMB Track is to introduce students to cutting-edge research in plant sciences that addresses critical questions in agriculture, medicine, and energy. Diverse research areas in plant biology are covered by the PMB faculty to address these questions: functional genomics, reproductive development, epigenetics, pathogenesis and immunity, circadian rhythms, genome engineering, and evolution.

The PMB Track offers a unique training and research opportunity for students interested in the plant sciences in the context of a broader education in all modern areas of molecular, cellular, and developmental biology. The program seeks to prepare students for careers in academic research, teaching, biotechnology, and other science-related occupations. To better prepare our students for careers in academia and industry, we encourage an inter-disciplinary approach that combines the development and use of skills in computer sciences, chemistry, math, and/or physics with research in plant molecular biology.

Entering first-year students in the PMB Track will be initially advised by the Director of the PMB Track. An advisory committee composed of different faculty members will then be selected during the first year for each student. The composition of the advisory committee can change through the years to better reflect the specific needs of each PMB student. All PMB students will take core and elective courses during their first two years. Graduate students in PMB are required to take two seminar courses: "Advances in Plant Molecular Biology" and "Introduction to PMB Research". Additional relevant coursework is dependent upon a student's specific interests, and students can choose from a wide array of elective courses. First-year students are required to carry out three laboratory rotations during their first year. The rotations help students to identify a specific area of interest in plant molecular biology and develop the expertise to complete a research thesis. At the end of the first year, students choose a thesis mentor and laboratory in which to perform their graduate work. The PMB Track is an inter-departmental program at Yale that includes faculty from the Department of Molecular, Cellular and Developmental Biology and the Department of Chemistry. The total time to complete the Ph.D. program is approximately five years.



WENYI RAN

Plant Molecular Biology Track

Neighborhood you live in
East Rock

Commute time from home to lab
15 minutes

Whether you walk, bike, drive, or use the shuttle to get to lab
Walk

Your favorite restaurant
Modern Apizza

Your favorite weekend activity
Hiking

Student or on-campus organizations you belong to
Greenhouse Botanical Club

Biggest surprise about New Haven or Yale
The biggest surprise about New Haven is the high humidity here, which resembles my hometown, and I have enjoyed the weather here since arriving.

The Plant Molecular Biology (PMB) Track is a great place for graduate students who have combined interests in both molecular, cellular, developmental biology, and plant biology. When talking about our Track, the first thing I can think of is our great community. The highly accomplished faculties are very supportive, fostering an environment that allows you to explore your own research interests and answer critical questions in the field. We also have a strong culture of collaboration among labs in PMB, which allows you to share and discuss ideas easily. Moreover, the design of the course curriculum is flexible which allows you to focus on learning your area of interest. In the first year, we will take a required course called "Advanced Plant Molecular Biology", which introduces you to the up-to-date mechanisms and techniques in the plant biology field. Other than that, we have high flexibility in choosing courses from specific areas of interest. With the great community and course curriculum, I learned a lot in my first year, and I cannot wait to see what I will accomplish after my training at Yale!

Yale University provides an outstanding environment to study plant biology. Plant facilities include 15 controlled environment plant growth rooms located in laboratory buildings. Plant growth facilities also include the Marsh Botanical Garden (MBG), an 8-acre site on campus that supports research and teaching activities. MBG includes 9400 square feet of greenhouse space and is staffed by professionals with expertise in plant culture, pest control, and related issues. MBG is also home to the Green Café, an outreach program that allows plant researchers at Yale to discuss popular topics in plant biology with the greater New Haven community. The PMB Track maintains its own seminar series, which allows graduate students and postdoctoral fellows at Yale to present their research and listen to external speakers studying diverse aspects of plant biology. The annual PMB and departmental retreats are other venues available for PMB students to present their work and interact with the science community at Yale. All the biology departments at Yale also sponsored their own weekly seminar series, which bring outstanding researchers from around the world to Yale to present their work.

Research Areas To contribute effective solutions to global climate change, food shortages, rapid loss of biodiversity, and new and evolving diseases that are threatening both the health of the planet as well as human health and well-being, graduate students in the PMB Track can study relevant topics in a wide range of research areas as listed below. In addition, graduate students are welcome to develop interdisciplinary projects combining several approaches and fields.

RESEARCH AREA	NO. OF FACULTY
Epigenetic regulation and genome engineering	2
Genetic diversity and genome engineering	2
Glycobiology and mass spectrometry	1
Metagenomics and bioremediation	1
Photosystems and Bioenergy	1
Plant circadian clock and protein degradation	2
Plant development, stem cells and organogenesis	2

There are approximately 8 faculty in the PMB Track. Follow the QR code at left to see which faculty work in each research area.

Admission Requirements Applicants to the Plant Molecular Biology Track must (1) have a strong foundation in basic sciences, such as biology, chemistry, physics, computer science, or mathematics, (2) be committed to pursuing research in plant sciences for their Ph.D., and (3) be interested in cross-disciplinary approaches to plant biology. We strongly encourage applications from international candidates as well as domestic candidates. We encourage all applicants to contact a primary faculty member of the Plant Molecular Biology Track prior to applying. When applying please list the primary faculty that you have contacted in the appropriate section of the application.

For further information, please contact:
Yannick Jacob, Director
Plant Molecular Biology Track
email yannick.jacob@yale.edu

Track 8

TRANSLATIONAL MOLECULAR MEDICINE, PHARMACOLOGY & PHYSIOLOGY

The Translational Molecular Medicine, Pharmacology and Physiology Track offers the opportunity for students to use the tools of biochemistry, cell and molecular biology, physiology, structural biology, systems biology and genetics to investigate the mechanisms of disease and pathogenesis (including: cancer, diabetes, obesity, heart disease, inflammatory diseases, aging and others), the development and molecular actions of drugs that treat these diseases, and how genes, proteins and small molecules are integrated to produce the specific functions of our cells, tissues, and organs. The faculty in this interdisciplinary Track are drawn primarily from the Departments of Pathology, Pharmacology, Cellular and Molecular Physiology, and Medicine, with participating faculty from Biomedical Engineering, Cell Biology, Comparative Medicine, Genetics, Immunobiology, Molecular Biophysics & Biochemistry, Microbial Pathogenesis, Molecular, Cellular & Developmental Biology, Neuroscience, Psychiatry, and Therapeutic Radiology, as well as the Yale Cancer and Stem Cell Centers.

Research Areas Projects currently being pursued by students in the Translational Molecular Medicine, Pharmacology, and Physiology Track cover many areas of contemporary biology, medicine and therapeutics. These encompass the study of cancer and many other human diseases, virology/immunology/hematology, cellular receptors and signal transduction, genetic/genomic/systems biology approaches, and others. The major realms of expertise represented by the 165 faculty in the Track are listed below, with the approximate number of faculty per area noted.

RESEARCH AREA	NO. OF FACULTY
Bioengineering	13
Cancer Biology and Therapeutics	62
Cytoskeleton and Cell Migration/ Morphogenesis	16
Genetics, Genomics and Proteomics	53
Hematology, Vascular Biology and Inflammation	32
Human Disease Pathology, Physiology and Intervention	91
Ion Channels, Pumps and Transporters	30
Membrane Biology and Biophysics	14
Metabolism	28
Neurobiology, Neural Networks and Neuropharmacology	38
Organ Physiology	30
Protein Sorting and Trafficking	11
Receptors and Signal Transduction	44
Sensory Physiology	11
Stem Cell Biology	25
Structural Biology	20
Systems Biology	23
Virology and Immunology	22

Follow the QR code at left to see a list of faculty who conduct research in each area.

Program of Study The program of study emphasizes an integrated view of experimental pathology, pharmacology and physiology, built upon a rigorous foundation of basic science.

The core first-year curriculum for this Track includes two of the following primary courses:

Physiological Systems
Molecular Mechanisms of Disease
Principles of Pharmacology
Physiological Function and Cellular Structure of Organ Systems

In addition, students will take the *TMMPP Seminar* course, in which specific subtopics of these disciplines are analyzed in depth based on articles from the current scientific literature.

During the first year, students will pursue three lab rotations selected based on their scientific interests and will present their work to Track faculty and trainees. At the end of year 1, students will choose a thesis lab and a specific graduate program, typically one of those associated with the Departments of Pathology, Pharmacology, Cellular and Molecular Physiology, or the interdepartmental program in Translational Biomedicine. In year 2 they will complete additional core coursework and electives tailored to the student's program, interests and/or thesis project. Students commonly take five or six courses within the first three semesters of graduate study. Students are advised during the first year by a designated Track Director.

The intellectual environment at Yale is outstanding, providing students with numerous opportunities to attend seminars on cutting-edge basic and clinical research from investigators in many disciplines (both in-house and abroad) as part of weekly departmental seminar series, symposia, "research-in-progress talks" (given by students and postdoctoral associates), and annual departmental retreats.

Admission Requirements Applicants should have a strong background in the biological, chemical, and/or physical sciences. Courses in biology, biochemistry, organic and physical chemistry, and mathematics at least through elementary calculus are recommended.

For further information, please contact:
Translational Molecular Medicine, Pharmacology, and Physiology Track
email tmmpp@yale.edu
web site http://bbs.yale.edu/molmed

AMOS ESPINOSA

Translational Molecular Medicine, Pharmacology, and Physiology Track

Neighborhood you live in
Downtown New Haven, in the Chapel Street District.

Commute time from home to lab
Because my lab is in the medical campus, walking takes ~15 minutes. I also own an electric scooter which shortens it to ~3 minutes!

Whether you walk, bike, drive, or use the shuttle to get to lab
I typically walk to campus. In the winter, I prefer to take the shuttle.

Your favorite restaurant
Camacho Garage (Hispanic), Da Legna at Nolo (Pizza), and Bar (Pizza)

Your favorite weekend activity
I enjoy using the weekend to catch up on my cardio exercise — either though the Payne-Whitney Gym or through a nice hike with friends in the Sleeping Giant or East Rock Parks. Sometimes, my friends and I take the train down to New York City for a short escape from New Haven.

Student or on-campus organizations you belong to
I am currently a member of the Medical Research Scholars Program.

Biggest surprise about New Haven or Yale
The architecture of the central campus which is right by my apartment was the biggest surprise thus far. Each building is intricate and has many unique and historical features to appreciate. It makes a leisurely walk through campus quite worthwhile.

My experience with the TMMPP Track was one filled with scientific collaboration, research diversity, and camaraderie among my peers. I was able to rotate in labs not only within the TMMPP Track, but also in those that have co-affiliations with other Tracks/departments (e.g., Immunology and Cell Biology) within the BBS Program; this allowed me not only to broaden my understanding in the field, but also to "test the waters" on what kind of biology interests me. The core curriculum of the Track was foundational to my understanding of the human body and how normal functions are implicated in many disease types both rare and common. Additionally, the Track honed my skills in scientific communication (i.e., writing) from the very beginning and allowed me and my peers to develop not just our critical reading, but also our ability to concisely impart our research to the scientific community. As I continue my graduate school journey, I am confident that Yale has equipped me and my peers with the resources and mentorship we need to achieve our goals.

Diploma ceremony for BBS and other students in the Graduate School of Arts & Sciences

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