A Guide for STEM Activities at Yale for First-Year Students

2019-2020

Edited 11-2019

Sandy Chang, MD/PhD
Associate Dean
Science & QR Education and
Undergraduate Research

Rationale for writing this guide

Dear first-year students,

I do a lot of advising for undergraduates majoring in STEM and am surprised by how often Yale undergraduates (even upper-level students) don't know where STEM information vital to their academic success is located on the Yale web space. This lack of knowledge is due in part to the sheer amount of information out there and to the multiple advising resources available at Yale. While these resources are important, first-years can easily get overwhelmed with so much information.

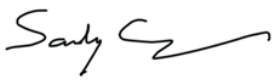
This guide highlights existing information and web links to help STEM majors navigate Yale resources more efficiently. While it is written with the first-year student in mind, more senior STEM students might also benefit from my career advice on medical and graduate schools.

There are three pieces of advice that I would like to offer to any first-year student, based on my own undergraduate experiences: (1) find a non-distracting place to study, away from your dorm, and go there every day to get your work done, (2) use course-based peer tutors for all your introductory STEM classes, if needed, and (3) go to your professors' office hours. I describe these points in greater detail below.

Note that the advice for pre-meds and pre-grads is just that - advice. It's not a plan set in stone for you to follow exactly, but a guide to get you started. It is essential for you to reach out to your first-year counselors (Frocos), residential college deans, heads of colleges, academic advisers, peer mentors and professors to get their take on what you want to accomplish at Yale. This is one reason why you chose Yale - the support here is incredible and we all want you to succeed in whatever you do.

Please help me make this guide better by giving me suggestions on additional information that I should include that could benefit you. I welcome any student to reach out to me. My e-mail is s.chang@yale.edu. I love eating breakfast or lunch with undergrads, so contact me to grab a meal.

Best,



Sandy Chang, MD/PhD
Associate Dean of Science and QR Education
Professor, Depts. of Laboratory Medicine, Pathology and MBB

Table of Contents

Proper E-mail Etiquette is Important to Make a Good First Impression

You won't believe how many undergrads address me with "Yo, Hey, Dude" in their e-mail messages. While these salutations are OK with your friends, do not use them to address your professors or deans! Proper e-mail etiquette is important to make a good first impression! The below was taken from an informative article written by Megan Roth, USA Today College, http://college.usatoday.com/2012/03/15/five-things-to-remember-when-e-mailing-a-professor/**.**

Follow these rules when emailing your professor:

1. **Be Formal**

   Always use a proper salutation when emailing a professor — even if you know the professor personally or professionally. Use "Dear" to begin the email and address him or her by the name you would use if speaking to the professor in person (Dear Dr. ____ or Dear Ms. ____). If your professor asks you to address him/her by first name, still use "Dear" to set up a respectful tone for the letter.

2. **Specify**

   Specify who you are by first and last name, and specify which class you are taking before diving into the specifics. Professors often teach anywhere from two to six classes per semester and usually have hundreds of students to serve. State your name, the class you are taking and the course section (the professor might teach three sections of your course and will need to know which one you attend).

3. **Be thorough**

   Any time you send a message, you should have two things in mind: goal and audience. Your audience here is a professor, who is an authority figure. Your goal could be any number of things, from clarifying the reading assignment to asking for an extension. Whatever your goal may be, you'll want to anticipate any questions the professor may have and incorporate the information into your message. For example:

Dear Professor Smith,
My name is John Green and I attend your ENC4214 section 9 course. I missed class on Tuesday and would like to find out the assignment for Thursday. The syllabus only lists a reading assignment, but I wanted to make sure nothing is due to hand in Thursday. Thank you for your help.
Sincerely,
John Green

The example above shows that John indicated that he had already checked the syllabus. This saves time and allows the professor to simply respond, "Yes, there is a written

assignment and it is _____" or "No, there is no written assignment," knowing that John has already gone to the syllabus.

4. Be kind

Professors are people, too. They have friends, families, hobbies and favorite foods. So, when you email a professor, remember that you are not writing to an entity, a building or a computer — you are communicating with a real person. Be kind, be thankful and never come across as demanding. This can be accomplished with the "You Attitude," a concept that asks you to consider yourself as the reader. What words or sentences would be off-putting? For example:

"Get back to me as soon as possible." This sentence is demanding, pushy and gives a direct command — something you want to avoid. After all, you are communicating with a higher-up.

"Please advise me at your convenience." This conveys respect and awareness. The professor is not a public servant and doesn't need to do anything as soon as possible for you.

Using the "You Attitude" establishes goodwill and respect and increases the chances you will receive the help you need. It also won't hurt to thank the professor at the end of the email, which establishes good rapport (see the example above).

5. Proofread

Perhaps the most important and final step - proofreading ensures that you come across as professional and caring. An email full of errors and faulty sentence structure is sure to enflame a busy professor. After all, if your writing is unclear, the reader has to work to understand what you want. Do the work on your end and make the message clear and easy to read. For a short message, don't get fancy. Use simple syntax (subject-verb-object) and proofread for run-on sentences, misspellings and other errors.

Together these tips will make emailing your professor a breeze.

Risa Sodi, Assistant Dean of Academic Affairs & Director of Advising and Special Programs, has a terrific website, https://advising.yalecollege.yale.edu, that contains numerous other resources that you will find useful.

How to Hit the Academic Ground Running

The first key to academic success at Yale is to know what your professor expects from you. Academic Strategies, https://academicstrategies.ctl.yale.edu/, a part of the Center for Teaching and Learning (CTL), is a very valuable website that teaches you how to start smart in your classes. This link, https://academicstrategies.ctl.yale.edu/starting-smart, contains invaluable information. Read EVERYTHING in it, then read it again.

A second key to academic success is to use the tutoring service, if needed, for all your intro STEM classes. I can't stress this enough. USE THE COURSE-BASED PEER TUTORS! This is especially true for large STEM intro classes. Visit this link, https://ctl.yale.edu/tutoring/quantitative-reasoning-science, to find out more about this essential resource.

Each residential college also host science and quantitative reasoning (QR) peer tutors with unique specialties with drop-in hours, https://ctl.yale.edu/tutoring/quantitative-reasoning-science/drop-residential-college-mathscience-tutors.

You can also request individual peer tutors, if needed. For more information contact Dr. Purushothaman, kailas.purushothaman@yale.edu.

A third key to success is to go to your professors' office hours every week. They have this time set aside especially for you to ask questions about anything related to class work. Professors often use this time to review a difficult topic or p-set, or to review contents covered in an upcoming exam. If you don't go, you will miss out on these VALUABLE nuggets of wisdom. Going to office hours is also a great opportunity to interact with your professors.

Many STEM departments will be rolling out a new peer mentor program for their majors this year. Juniors and seniors chosen by the departmental Director of Undergraduate Studies (DUS) will function as ambassadors to teach first-year students more about their majors. Reach out to the DUS in a major you are interested in, get the e-mail address of a peer mentor and then grab a meal with one of them. Upper-level students are one of the best resources to get the low-down of a particular major.

Finally, those of you in the STARS I Program will have your own peer mentors assigned to you. Take advantage and meet with them often, they are an invaluable source of STEM information. If your STARS I mentor cannot answer a question, she/he will direct you to other STARS I mentors who can. You are also free to get in touch with other STARS peer mentors to ask them questions. https://science.yalecollege.yale.edu/stars/stars-i-academic-year-program

Recommended Small Enrollment Science Classes for First-Years

Our introductory biology, chemistry and physics courses are fabulous and well taught, and you need to take all of them if you are a MBB/MCDB/EEB/BME major and/or pre-med. But they are large classes, and some first-years might find it intimidating to get to know their professors. The solution is to take one large intro science class and a smaller science class on some science topic that interests you. Below are the small STEM classes that I recommend you shop. They come in two flavors; first-year seminars or Course-based Undergraduate Research Experience (CURE) classes.

First-year STEM Seminars https://yalecollege.yale.edu/academics/special-academic-programs/first-year-seminar-program
These classes delve into a specific topic in detail. They are capped at 18 students (classes are typically much smaller), so you really get to know your professor and classmates well. If you love to interact closely with a professor and to talk about science in a small group setting, this is your type of class. Many professors also take their seminar classes on cool field trips; I took mine to the Museum of Natural History in NYC last year and we ate amazing Greek food. I loved teaching first-year seminars so much that I'm teaching TWO this year. Be aware that there is a lottery for these classes, so you might not get into the one you want. Remember, you only get to take these classes as first-years, so don't miss the opportunity!

Fall 2019

* **APHY 050a / PHYS 050a, Science of Modern Technology and Public Policy** Daniel Prober
Examination of the science behind selected advances in modern technology and implications for public policy, with focus on the scientific and contextual basis of each advance. Topics are developed by the participants with the instructor and with guest lecturers, and may include nanotechnology, quantum computation and cryptography, renewable energy technologies, optical systems for communication and medical diagnostics, transistors, satellite imaging and global positioning systems, large-scale immunization, and DNA made to order. SC RP MW 2:30pm-3:45pm

*** ASTR 040a / PHYS 040a, Expanding Ideas of Time and Space** C. Megan Urry
Discussions on the nature of time and space. Topics include the shape and contents of the universe, special and general relativity, dark and light matter, and dark energy. Observations and ideas fundamental to astronomers' current model of an expanding and accelerating four-dimensional universe. Enrollment limited to first-year students. Preregistration required; see under First-Year Seminar Program. SC TTh 11:35am-12:50pm

*** CLCV 034a / HIST 037a / HSHM 002a, Medicine and Disease in the Ancient World** Jessica Lamont
Examination of ancient medicine considering modern fields of pathology, surgery, pharmacology, therapy, obstetrics, psychology, anatomy, medical science, ethics, and education, to gain a better understanding of the foundations of Western medicine and an appreciation for how medical terms, theories, and practices take on different meanings with changes in science and society. All readings in English. Enrollment limited to freshmen. Preregistration required; see under Freshman Seminar Program. HU
MW 9am-10:15am

*** EVST 007a, The New England Forest** Marlyse Duguid
Exploration of the natural history of southern New England, with specific focus on areas in and around New Haven. Pertinent environmental issues, such as climate change, endangered species, and the role of glacial and human history in shaping vegetative patterns and processes, are approached from a multi-disciplinary framework and within the context of the surrounding landscape. Th 1pm-5pm

*** EVST 040a, Collections of the Peabody Museum** David Skelly
Exploration of scientific questions through the study and analysis of objects within the Peabody Museum's collections. Formulating a research question and carrying out a project that addresses it are the core activities of the course. Enrollment limited to first-year students. Preregistration required; see under First-Year Seminar Program. SC TTh 11:35am-12:50pm

*** G&G 010a / EVST 010a, Earth, Resources, Energy, and the Environment** Mary-Louise Timmermans
Humankind's interactions with, and place within, the natural world. Plate tectonics and natural disasters, biological evolution and mass extinction, human evolution, population growth and ecology, industrial resources, groundwater and pollution, fossil fuels and energy

transitions, the carbon cycle and greenhouse gases, paleoclimates, current global warming, alternative energies, and a planetary perspective on the Earth as a singular oasis in space. SC TTh 11:35am-12:50pm

* **MB&B 060a, Molecular Medicine** Sandy Chang
The main purpose of this course is to use benign and malignant hematological disorders to introduce fundamental concepts in molecular and cellular biology. Students emerge from this course with a firm understanding of the molecular pathways perturbed in various hematological disorders and the therapeutics currently used to exploit these pathways for disease treatment. Through lectures and reading of primary scientific literature, students learn about landmark discoveries in hematology and how these discoveries contribute to understanding of the normal hematopoietic system, and when perturbed, how diseases arise. Students also learn to (1) read primary scientific literature, (2) synthesize this material to present to the class and (3) learn how to write a short grant proposal. These skills are essential for any successful scientist or physician, and it's important to master them early. Enrollment limited to first-year students. Preregistration required; see under First-Year Seminar Program. Prerequisite: score of 5 on the AP Biology exam or AP Chemistry exam. SC MW 1pm-2:15pm

*** MCDB 065a, The Science and Politics of HIV/AIDS** Robert Bazell
Study of the basic virology and immunology of HIV/AIDS, along with its extraordinary historical and social effects. Issues include the threat of new epidemics emerging from a changing global environment; the potential harm of conspiracy theories based on false science; and how stigmas associated with poverty, gender inequality, sexual preference, and race facilitate an ongoing epidemic. For all first-year students regardless of whether they are considering a science major. SC TTh 2:30pm-3:45pm

*** MCDB 050a, Immunology and Microbes** Paula Kavathas
Introduction to the immune system and its interaction with specific microbes. Attention both to microbes that cause illness, such as influenza, HIV, and HPV, and to microbes that live in harmony with humans, collectively called the microbiome. Readings include novels and historical works on diseases such as polio and AIDS. SC RP TTh 2:30pm-3:45pm

*** SCIE 030a and SCIE 031b, Current Topics in Science** Douglas Kankel
A series of modules in lecture and discussion format addressing scientific issues arising in current affairs. Topics are selected for their scientific interest and contemporary relevance, and may include global warming, human cloning, and the existence of extrasolar planets. Credit for SCIE 030 upon completion of SCIE 031; one course credit is awarded for successful completion of the year's work. SC ½ Course cr per term F 1:30pm-3pm

Spring 2020

*** CPSC 035b, Twenty-First Century Electronic and Computer Music Techniques** Scott Petersen
Exploration of twenty-first century electronic and computer music through the diverse subjects and issues at the intersection of technology and new music. How computers have changed and challenged the analysis, composition, production, and appreciation of music over the last fifty years. Knowledge of basic music theory and the ability to read Western musical notation is assumed. TTh 2:30pm-3:45pm

*** HIST 006b / HSHM 005b, Medicine and Society in American History** Rebecca Tannenbaum
Disease and healing in American history from colonial times to the present. The changing role of the physician, alternative healers and therapies, and the social impact of epidemics from smallpox to AIDS. Enrollment limited to freshmen. Preregistration required; see under Freshman Seminar Program. WR, HU TTh 1pm-2:15pm

* **MATH 077b, Math as a Creative Art** Patrick Devlin
This course focuses on the creative process central to mathematical reasoning rather than mechanical manipulation of symbols. Unlike a typical math class, this course deals entirely with the aesthetics of math, and no prior mathematical background is required or assumed. Topics include puzzles, strategy games, social networks, symmetries, number theory, infinity, and beyond. Enrollment limited to first-year students. Preregistration required; see under First-Year Seminar Program. QR TTh 9am-10:15am

* **MB&B 050b, Topics in Cancer Biology** Sandy Chang
Introduction to cancer as a genetic disease, with a focus on major discoveries in cancer biology that offer mechanistic insights into the disease process. A brief history of cancer; influence of the genomic revolution on cancer diagnostics; molecular defects underlying specific cancers; current and future cancer therapeutics. Patient case studies highlight specific molecular pathways and treatment strategies. Enrollment limited to first-year students with a strong background in biology and/or chemistry, typically demonstrated by a score of 5 on Advanced Placement examinations. SC MW 1pm-2:15pm

* **MCDB 040b, The Science and Politics of Cancer** Robert Bazell
Fundamentals of cell biology, Darwinian evolution, immunology, and genetics that underlie cancer; the history of cancer science and treatment; historical and current policy issues. Enrollment limited to first-year students. SC TTh 1pm-2:15pm

*** THST 097b, Anatomy in Motion** Bronwen MacArthur
The connection between advances in human anatomy and kinesiology—the science of human movement—and dance practices from the early 1900s to the present. Study of seminal texts and practical exercises that drove the research of Frederick M. Alexander, Mabel Elsworth Todd, Barbara Clark, and Lulu Sweigard and the application of their ideas in contemporary movement practices today. Topics include the synthesis of dance and science; the reeducation of alignment, posture and balance; the use of imagery; and the unification of mind and body. No prior dance experience required. Enrollment limited to freshmen. Preregistration required; see under Freshman Seminar Program. HU TTh 9am-10:15am

Course-based Undergraduate Research Experience (CURE) Classes

Through funding from the Howard Hughes Medical Institute, Yale has designed courses intended to increase hands-on research experiences for first-year students and sophomores via lab courses that have no prerequisites. These CURE classes mix lectures with hands-on research projects and are an excellent way for first-years and sophomores without previous research experiences to learn about research methodologies in a specific discipline. E-mail the course instructors for further information. Some class enrollments may be capped.

Fall 2019

BENG 205a, Discovery and Design in Biomedical Research Jay Humphrey
Multi-disciplinary and team-based research approach to the study of clinical dilemma. Focus on an important health care problem, bringing to bear concepts and principles from diverse areas to identify possible solutions. Study of precision regenerative medicine as it involves aspects of bioengineering, materials science, immunobiology, mechanobiology, computational modeling, and experimental design, as well as hands-on fabrication and materials testing (i.e., data collection and analysis).
Prerequisites: MATH 115 and MATH 120 or ENAS 151. SC TTh 9am-10:15am

Spring 2020

ARCG 253b / ANTH 253b, Introduction to Experimental Archaeology Roderick McIntosh and Ellery Frahm
Experimental archaeology is one of the most important tools to develop and test models which link human behaviors and natural forces to the archaeological record. This class explores the elements of good experimental design and procedures.
ANTH 316L, ARCG 316L recommended. SO W 3:30pm-5:20pm

MCDB 175Lb, Exploring the Microbial World Iain Dawson
This course is designed to provide an immersive, introductory biology lab for first years and sophomores. Students conduct semester long projects to develop methods and tools to study the growth patterns of an unusual filamentous bacteria, *Bacillus mycoides*. Biol 101-104 is a co- or-prerequisite. Restricted to first year and sophomore students. Preference given to students with no prior research experience. Instructor permission required. SC ½ Course cr M 2:30pm-5:30pm

EENG 245b / CPSC 235b, Self-Driving Cars: Theory and Practice Man-Ki Yoon
This course explores the theory and practice of building self-driving cars using advanced computing technologies. Topics include embedded system programming, sensor fusion, control theory, and introductory planning and navigation techniques using machine learning and computer vision. Students work in small teams to design and build miniaturized self-driving cars that autonomously navigate an indoor track that resembles real road environments. The final project involves driving competitions and project report/presentation of their work. Prerequisite: CPSC 112, 201, 223, or equivalent. Instructor's permission is required to waive the prerequisites. Enrollment limited to 18. QR HTBA

E&EB 175Lb, Virus Discovery and Evolution Alita Burmeister
An inquiry-based, hands-on introduction to sampling bacteriophages (bacteria-specific viruses) from natural environments. Emphasis on lab methods to characterize viruses via growth assays and genome sequencing, and to experimentally evolve viruses on bacteria. Readings and discussion on virus biodiversity, role of viruses in the environment, and virus applications to solve human problems. SC ½ Course cr T 1pm-5pm

Biology Laboratory Courses

If you are eager to do undergraduate research in biology but have no previous lab experience, you might want to consider taking one of the MCDB lab courses below. Dr. Moreno does a great job making Yale undergrads familiar with the latest techniques in biological research and prepares them to think like a scientist. After taking her lab course(s), you'll hit the ground running when you do research in a Yale bio lab over the summer. Her labs are great for preparing students who want to secure a Yale First-Year Summer Research Fellowship, https://science.yalecollege.yale.edu/yale-college-first-year-summer-research-fellowship-sciences-engineering, or a position in the STARS Summer Research Program, https://science.yalecollege.yale.edu/stars/stars-i-summer-research-program.

Also, if you are pre-med and are NOT doing any biology related research, you will need to take two semesters of biology lab. These labs below are very good choices. Even if you have extensive independent research experience, it's a good idea for pre-meds to take 1 semester of biology lab at Yale.

Fall 2019

MCDB 221La, Model Organisms in Biological Research Maria Moreno
An introduction to research and common methodologies in the biological sciences, with emphasis on the utility of model organisms. Techniques and methods commonly used in biochemistry, cell biology, genetics, and molecular and developmental biology; experimental design; data analysis and display; scientific writing. With permission of instructor or concurrently with or after BIOL 101, 102 or 103. WR, SC ½ Course cr HTBA

Spring 2020

MCDB 201Lb, Molecular Biology Laboratory Maria Moreno
Basic molecular biology training in a project-based laboratory setting. Experiments analyze gene function through techniques of PCR, plasmid and cDNA cloning, DNA sequence analysis, and protein expression and purification. Instruction in experimental design, data analysis, and interpretation. Concurrently with or after MCDB 200, or with permission from instructor. For freshmen and sophomores interested in research integrated laboratory experience. Special registration procedures apply. Interested students must contact the instructor and attend an organizational meeting during the first week of classes. WR, SC ½ Course cr HTBA

STEM classes without prerequisites

If you are looking to fulfill a SC or QR credit, and want to take a class without any prerequisites, look here for a list of Science Courses without prerequisites, https://science.yalecollege.yale.edu/academics/faculty-resources/science-courses-without-prerequisite, and here for Quantitative Reasoning courses without prerequisites, https://science.yalecollege.yale.edu/academics/courses/qr-courses/qr-courses-without-prerequisite.

Undergraduate Research

Undergraduates in labs with caring mentors tell me that doing independent research is the most rewarding activity during their Yale career. I think all STEM majors should try doing some form of independent research for at least a summer. If you hate it, fine, you've tried it. If you love it, well, I don't have to tell you how thrilling making new discoveries can be. I love it so much I made it my career. You can too.

The Science and QR website, https://science.yalecollege.yale.edu/, should be your go-to place if you are interested in independent research with a lab at Yale. It contains information on why and when you should do research, how to find a mentor, and fellowships that support undergrad STEM research. Read every section, especially the sections titled, "*Entering Research*" and "*Choosing a Mentor*". Then read those sections again. Be sure to also check out the schedule for my monthly workshops on how to find a mentor, how to write a research proposal, etc. on the link above.

The Yale Center for International and Professional Experience also has a website, https://funding.yale.edu/fellowships, that contains information on fellowships and funding as well as other summer opportunities; although most of these are not STEM fellowships.

Another useful website is, https://yura.yale.edu/. The Yale Undergraduate Research Association created a database that allows you to type in key science words to look up Yale researchers working in those areas. Very cool and very helpful.

Are you a woman and/or a student from an underrepresented group? Then the STARS Programs might be for you. Check out these amazing programs, https://science.yalecollege.yale.edu/stars. They have been supporting STEM students since 1995!

Have you already found a great lab, but need funding? Here's what you should look at, https://science.yalecollege.yale.edu/yale-science-engineering-research/fellowship-grants. There is a fellowship specifically to support **first-year students**, https://science.yalecollege.yale.edu/yale-college-first-year-summer-research-fellowship-sciences-engineering, and a fellowship to support **sophomores and juniors**, https://science.yalecollege.yale.edu/yale-undergraduate-research/fellowship-grants/yale-college-deans-research-fellowship.

If you are on financial aid and want to do research in an institution back home over the summer, now you can! Check out this link for more information on the Domestic Summer Award (DSA) that you can be used to fund a research position, https://ocs.yale.edu/yale-college/domestic-summer-award-dsa.

Please note that there is no funding available for students doing research during the academic term except for the STARS II program which can provide financial support in your junior and senior years, https://science.yalecollege.yale.edu/stars/stars-ii-program.

Do you want to do STEM research in a foreign country? Find a professor who is willing to host you, formulate a research project and apply for the Tetelman and Bates Fellowships, https://science.yalecollege.yale.edu/yale-undergraduate-research/fellowship-grants/tetelman-fellowship-international-research-sciences.

Places to Study
(courtesy of Grace Kim '20)

It is essential for you to find a good, safe, quiet place to study, ideally away from your dorm room (too many distractions). I always studied in the Sterling library stacks, floor 3M. It's nice and quiet up there, and a bit spooky which made me work fast. I stayed there every night from 6PM onwards until I finished studying. Get your study routine down, and stick to it. Be smart, make sure where you study is safe, especially if you are studying by yourself. Below are some places to study in and around Yale.

Residential Colleges:

- Computer Labs
- Buttery (especially silent and empty in the mornings to mid-afternoon)
- Common Room (for collaborative study—go here if you want to talk)
- Library (for *quiet*, independent study)
- Dining hall (some dining halls are open for studying at night)
- Seminar Rooms
- Student Meeting Spaces

Science Hill

- KBT (Klein Biology Tower) Café
    - Located on top of science on the first floor of Klein Biology Tower
    - Great for grab & go use of your breakfast swipe (8:00-10:30am) and lunch swipe (11:00am-2:30pm)
- Kroon Hall School of Forestry & Environmental Studies
    - Go to the third floor for desks and windows
- CSSI (Center for Science and Social Science Information)
    - Located at the basement of KBT
    - Large computer lab and library (double screens, Matlab/Solidworks/R installed on most computers)
    - Open until 11pm (Monday through Thursday)
    - Study space with limited computers open 24/7
- Divinity School Library
    - Way up science hill—take the Blue (going up)/Red (coming down) line shuttle if needed
    - Beautiful, peaceful library with lots of light (Recommend: The Day Reading Room)
    - Your lunch swipe works in the Divinity School Refectory
- Rosencrantz Hall Political Science building
    - Across the street from the new colleges
    - Lots of light, couches, tables
    - Multiple floors to study at with a computer room in the basement
- CEID (Center for Engineering, Innovation, and Design)
    - Located between SSS and Watson Hall
    - Rooms with whiteboard walls available upstairs as well
    - A lot less popular in the mornings on weekends (can get really crowded during exam seasons)
    - group study, computers with technical programs installed
    - Get membership for 24/7 swipe access here: http://ceid.yale.edu/member/#membership
- Watson Hall
    - CS Department building across from Grove Cemetery
    - Has study space on 2nd floor

Hillhouse Ave

- Watson Center
    - Across the skating rink on Sachem Street
    - Classrooms and study spaces throughout
- 17 Hillhouse
    - 1st floor computer labs, printers, and whiteboard walls
    - Study spaces and whiteboards on upper levels as well
- Dunham Lab
    - Has computer lab on first floor with technical programs installed
    - Classrooms and whiteboards throughout

- Mason Lab
    - Common room (1st floor right inside entrance)

On Old Campus

- Phelps Hall
    - Located on the left as you walk through Phelps Gate into Old Campus
    - Classrooms with bright lighting and white boards
- LC (Linsly-Chittenden Hall)
    - Located across from Connecticut Hall on Old Campus
    - Classrooms and seminar rooms throughout
    - Top floors tend to be the most empty

Libraries

- Sterling Library Link to Study Spaces (Reservation Links included): http://web.library.yale.edu/places/to-study
- *Would highly recommend signing up for the Sterling Library Tours (emails sent out for sign-ups during the fall semester) which teaches you about library resources, such as your personal librarian, how to find books yourself with a call number, and how the Yale library system is organized*

Link has all the different available locations but some recommendations for locations more commonly used by undergraduate students:

- Bass Library
    - Located on Cross Campus underground
    - Can reserve rooms on the lower level for group study/meeting
- Sterling Library
    - Located on Cross Campus; big center building
    - Linonia and Brothers reading room (through main doors and take a right after you pass security; more comfortable atmosphere than the more popular Starr Reference Room)
    - Stacks (straight through the main doors and up the elevator to any floor; has individual desks along the walls)

Coffee Shops

- Jojo's
    - Located on the corner of Park and Chapel
    - Great coffee and food (and they give free food to the homeless, so supporting them is good!)
    - Relatively quiet
    - Limited tables and seating
- Koffee?
    - Located off Whitney on Audubon Street
    - Good coffee, hipster ambience, comfy seating
- Blue State Coffee
    - Has two locations: Wall Street and York Street
    - Wall St is closest Very standard coffee shop feel, lots of table
- Book Trader
    - Located at Chapel and York Street
    - Great coffee, lots of tables, outdoor seating
- Willoughby's
    - Has two locations: behind TD (Timothy Dwight College) on the corner of Church and Grove or across from JE (Jonathan Edwards College) on York Street
    - Good iced coffee and tea
    - Lots of tables
- Starbucks
    - Located on College Street across from Old Campus
    - The normal Starbucks atmosphere
    - Often crowded and busy
    - Good energy booster if you are having trouble staying awake; a bit distracting if you are trying to focus

Advice for Pre-Meds

Going to medical school to become a physician is a big decision to make, so make sure you know what you are in for. Besides four years at Yale, there are four years of medical school, four to seven years of medical residency in a speciality, one to two years of fellowship, and THEN you get to practice medicine. That's a long road. Make sure it's really what YOU want to do. I recommend that you volunteer for at least one year in a hospital to get hands-on experience taking care of patients, and make sure you like doing this before committing to a career in medicine.

Yale undergrads do very, very well when it comes to applying to and getting into medical schools, with almost 90% getting into a US medical school. Compare this with the ~45% national average. This high acceptance rate is unrelated to a student's major. For example, our English majors do as well as our MB&B majors in terms of medical school acceptances. I'm not saying that all of you will get into Yale Med or Harvard Med, but getting into any US medical school means that you will receive solid training in basic science/clinical medicine to become a good doctor. Remember, the secret is that for your future medical career success, **the quality of your residency program is more important than the medical school you attended**. So, don't stress out about getting into medical school! Do the best you can in your classes, volunteer in a hospital, and you'll have a very good chance of becoming a doctor after you graduate from Yale.

To get into medical school, you must take classes that satisfy the pre-med requirement. Yale does not have a "pre-med major". To help you think about when/what you should take, I've listed a typical pre-med curriculum below. Disclaimer: I sit on the MD/PhD committee at Yale Medical School so I am familiar with what Yale Medical School requires, but the specific class requirements sometimes vary from state to state. Below are ***my recommendations only***, not the final word, but it applies to most med schools in the US.

You will need to decide by the end of sophomore year whether you want to go directly into med school after graduation from Yale, or whether you want to take a year or more off (a gap year). If you don't take a gap year, you must finish all your pre-med requirements by the end of junior year. Most undergrads now take a gap year after graduation before applying to medical school. It is much less stressful if you finish the medical school requirements over a 4-year period instead of 3. Post-baccalaureates (post-bacs) use their gap year(s) to finish a research project or to participate in clinical research. Medical school admission committees really like students with gap year experience. My suggestion is that you seriously consider taking one or two years off after graduating from Yale to do something interesting before applying to medical school.

The Office of Career Strategy, https://ocs.yale.edu/, is the place to get started if you are considering medical school. This link, https://ocs.yale.edu/yale-college/career-options, will help you begin your medical school application process. Make an appointment to speak with the wonderful OCS health professionals during the beginning of your sophomore year, when you are sure medical school is for you. While OCS professionals

are terrific at giving great advice, they are busy working with current juniors so don't be surprised if they do not get back to you immediately. Look out for my career talks on, "*Things to consider for medical and graduate schools*", on the Science & QR website, if you need additional information.

My recommendations when to take specific pre-med classes
*This applies to any major at Yale.

If you <u>do not</u> want to take a gap year:

First-year:
General Chemistry (Chem 161+165 or 163+167)
Gen Chem Lab (Chem 134L+136L)
If you place into Freshmen Organic Chem: (Chem 174 and/or Chem 175); see notes A
Organic Chem Lab (Chem 222L and/or 223L); see notes A
Math 112, 115, 116 or 120 (depending on your preparation and major requirements)
English 114
First-year seminar, CURE class or take a bio lab course (see p. 10 for more info).

Summer: Do research at Yale and start volunteering at a hospital/patient care facility.

Notes A: If you are choosing between taking either general chem or the intro bio sequence during your first-year, my recommendation is to start general chemistry first. The chemistry sequence has to be taken in order (general chemistry, organic chemistry, biochemistry) and if you don't start taking it during your first-year, you will either have to take a chemistry class in the summer or during your senior year (which means you will have to take a gap year).

Math is tricky - you need a year of calculus for med school, but most (not all - check your favorite schools) med schools will consider that you've fulfilled your math requirement if you received a 5 in BC calculus in HS. If you didn't take BC in HS, or took AB instead, you might need to take at least one semester of calculus at Yale. Talk to Kristin McJunkins in Office of Career Strategy to make sure.

Most med schools now require only ONE semester of organic chemistry plus ONE semester of organic chem lab (although many medical schools in Texas still require 1 year of orgo plus one year orgo lab). Check the specific requirements of your favorite schools to make sure. If you love orgo, take the full year.

Sophomore year:
Organic Chemistry 220 (1 semester)
Organic Chemistry Lab 222L (1 semester)
[or 1 semester of Biochemistry MBB 300 or MCDB 300]
Bio 101, 102, 103, 104
Intro Psychology course (1 semester)
Intro Statistics course (1 semester)

A second English course or a course that will give you a WR credit

Summer: Do research at Yale or at another institution. Start volunteering in a hospital if you haven't started already. Or finish that language requirement in a foreign country.

Junior year:
Biochemistry MBB300 or MCDB 300 (1 semester)
Physics 170,180 or 200 + lab (2 semesters lecture and 2 semesters lab)
Independent Research for credit (if your major allows for this)

Study for MCATS (shoot for a score of 515 or better)

Summer: Apply to med schools: make sure you apply as early as possible

Notes B: If you didn't do any independent research in the biological sciences, you will need to take 2 semesters of biology lab courses - this requirement varies among med schools.

I DO NOT recommend most students doing research during their sophomore **academic** year. It's too much stress to do both research and academics well at this time, my office can't fund you, and you can't get course credit. Save independent research for the summer. You will be glad you did.

Senior year:
Plan accordingly for medical school interviews.

If you <u>are</u> planning to take a gap year:

Freshman year:
General Chemistry (Chem 161+165 or 163+167)
Gen Chem Lab (Chem 134L+136L)
If you place into Freshmen Organic Chem: (Chem 174 and/or Chem 175); see notes A
Organic Chem Lab (Chem 222L and/or 223L); see notes A
Math 112, 115, 116 or 120 (depending on your preparation and major requirements)
English 114
First-year seminar, CURE class or take a bio lab course (see p. 10 for more info).

Summer: Do research at Yale and start volunteering at a hospital/patient care facility.

See **Notes A** above.

Sophomore year:
Organic Chemistry 220 (1 semester)
Organic Chemistry Lab 222L (1 semester)
[or 1 semester of Biochemistry MBB 300 or MCDB 300]
Bio 101, 102, 103, 104

A second English course or a course that will give you a WR credit
Finish math requirement

Summer: Research at Yale or at another institution. Start volunteering if you haven't started already.

Junior year:
Biochemistry MBB300 or MCDB 300 (1 semester)
Intro Psychology course (1 semester)
Independent Research for credit (if your major allows for this)

Summer: Continue doing research and volunteering.

Senior year:
Physics 170,180 or 200 + labs (2 semesters each)
Intro Statistics course (1 semester)
Independent Research for credit course

Study for MCATS (shoot for a 515 or better) and apply to med schools.

See Notes B above

One year after graduating from Yale: Med school interviews

Additional things to consider
While good grades and a good MCATS score are important, medical schools are also looking for students with extensive clinical volunteering activities, demonstrated community service commitments and leadership qualities. Below are just a few of the programs that you might want to explore and possibly get involved in. Please note that these are only a sampling of the vast array of opportunities available at Yale and New Haven. While these programs have all received high marks from my students who participated in them, it is important for you to make sure they are right for you.

For physician shadowing:
https://yalemedicalprofessionsoutreach.wordpress.com/shadowing/physician-shadowing/

Clinical volunteering opportunities:
Elder Horizons:
https://www.ynhh.org/about/research-education/elder-horizons-program.aspx

Haven Free Clinic:
https://www.ynhh.org/about/research-education/elder-horizons-program.aspx

Yale New Haven Hospital Volunteering:
https://www.ynhh.org/about/community/volunteers.aspx

Service work:

The Dwight Hall https://dwighthall.org/ link is great site to explore the numerous service programs for you to get involved in.

Teach at Yale splash-sprout: https://yale.learningu.org/

Advice for Students Interested in Pursuing a PhD Degree

Getting a PhD means a career in science. You can go the academic route and climb that tenure ladder, or work as a scientist in industry. In any case, getting a graduate degree makes you much more marketable than working in a job right after you graduate from Yale. The last statement generally does not apply to engineering majors or computer science majors, where getting a Masters or a PhD is not usually as important as it is for those in the biological or physical sciences. The Office of Career Strategy, https://ocs.yale.edu/, is the place to get started if you are considering graduate school. For a typical PhD track, it's five years in a PhD program, followed by four years as a postgraduate doctorate (a postdoc) before you apply for an academic position. Doing a postdoc might not be as important if you are going into industry. STEM PhD programs are tuition-free and you get a stipend of ~$30,000 a year to live on. Getting paid to do science is great, if you love doing it!

All Yale STEM departments do a great job preparing their majors academically to succeed in graduate school. In general, undergrads should do the BS track, and take the hardest classes offered by that major. Below are some of the things I look for when I look at applications for Yale's PhD graduate program in the biological sciences.

How good are the letters of recommendation from the research mentor(s)? This is the first thing I look at. An outstanding mentor's letter is essential to getting into a top grad school. Make sure you know your mentor well, both on a scientific and a personal level. Talk to your mentor about his/her career as a scientist, and why you want to go that route.

How much independent research did the candidate accomplish? Going into grad school means that you must love doing research for many years. It helps if you have done significant bench work as an undergraduate, demonstrate that you truly love science and are good at it. So, get into a lab the summer after your first-year and every summer after that, and do research for credit during your junior and senior academic years.

Did the candidate publish? It helps tremendously if you can get an authorship on a publication before you apply to grad school. It often pays to do a "postbac" in your lab after graduating from Yale to get that publication. Talk to your research mentor about this opportunity a year before you need the position.

Good grades do matter. A lot of students assume that grades don't matter as much for getting into grad school vs. med school. While there's some truth to that, good grades are still important to get into the very best graduate schools. Do the best you can, especially in your STEM classes. The same goes for the Graduate Record Examination (GRE), but Yale students shouldn't have any problems doing well on it.

Could the candidate describe his/her research in detail? Here's where the interview's important. I've faced plenty of applicants who look great on paper but can't talk about their research, or only have a superficial grasp of what it is that they tried to accomplish. Don't be that person. You need to know your research inside and out.

Advice for Students Interested in the MD/PhD Program

For those of you interested in combining basic science research interests with medicine, then the MD/PhD combined degree program that trains physician-scientists is for you. This is what I did after graduating from Yale. This is typically a seven-year program; two years of medical school followed by four years of PhD, with a final year of clerkships. Then you do a residency (four to seven years) followed by (or concurrently) with a postdoc (four years). This is a long journey; I was 36 before I landed my first real job as an Assistant Professor. But the MD/PhD program is extremely rewarding if you like doing medically relevant research and apply it to the bedside. In addition, it's free: medical school tuition is waived, and you get paid a ~$30,000 stipend during your PhD years, just like any STEM graduate student. MD/PhD physician-scientists typically do 80% research and 20% clinical activities. Using myself as an example, I run a basic science cancer research lab and sign out clinical chemistry cases 1 week out of every month. You are expected to obtain independent grant funding to support your research, and mentor graduate and medical students.

Please visit this link to see the latest outcome survey for those enrolled in a MD/PhD program, https://members.aamc.org/eweb/upload/AAMC-National-MDPhD-Program-Outcomes-Study-2018.pdf.

The National Institute of Health (NIH) funds the Medical Scientists Training Program (MSTP), but almost all medical schools also have their own funding to support additional MD/PhD students. Examine this link for more information about the MSTP, https://www.nigms.nih.gov/Training/InstPredoc/Pages/PredocOverview-MSTP.aspx.

Note: If you are a student supported by the MSTP and after your MD/PhD training decide NOT to do academic research but to go into private practice, you will have to pay back to the federal government the tuition and stipend that supported your educational training. Remember, this program is to train future ACADEMIC physician-scientists, not private practice physicians.

To get into a MD/PhD program, you need to do everything I outlined in the pre-med and graduate school sections. Yale undergrads competitive for this program are usually STEM majors with intensive research experiences. Grades matter, and undergraduate publications are a definite plus. Come and talk to me if you are interested in this challenging program.

Advice for students interested in Computer Science
(courtesy of Jeffrey Zhou ’21, BS in CS and MBB)

Programming Courses (no CS background)
Don’t be afraid to major in computer science, even if you have no programming experience! A lot of other students have been in the same boat and were just as successful as their peers. Yale offers two introductory programming courses: CPSC 100 (commonly known as CS50) in the fall, and CPSC 112 in the spring. These courses also provide an introductory survey of broader computer science concepts, such as data structures and algorithms. If you’re planning on majoring in computer science, CS50 may be better, as it not only gives you earlier exposure to programming, but also focuses primarily on C and Python as programming languages; C is used in the other core computer science courses, while Python is used frequently in industry.

If you do choose to take CS50 in the fall, you can take an additional core computer science class in the spring. The first core programming course is CPSC 201, which focuses heavily on fundamentals such as recursion. Some students who feel confident after taking CS50 choose to skip CPSC 201 and instead take CPSC 223, although this is not recommended; you will still need to take an additional course to replace CPSC 201 in the future.

Programming Courses (CS background)
Most students who come to Yale with prior programming experience choose to take CPSC 201, which will help solidify some fundamental programming concepts. Rarely, exceptionally well-prepared students will begin with CPSC 223 as their first programming course, or even more rarely with CPSC 323. If you have an extensive background in computer science, shop these courses and talk with the instructors to decide which is most appropriate for you.

Theoretical Courses
There are two tracks for fulfilling the theoretical computer science requirements. Each consists of a fall semester course mathematical tools relevant to computer science, and a spring semester course on the design and analysis of algorithms. CPSC 202/CPSC 365 is the easier of the two sequences, and the one that the majority of computer science majors take. CPSC 202 requires no calculus or programming experience (although it is definitely helpful to see how the math concepts can be applied), so it can be taken first year fall. However, it requires a different kind of thinking from typical math courses that most students have taken. CPSC 365 requires a more holistic understanding of computer science and has CPSC 223 as a prerequisite, so most students will wait until their sophomore or junior year to take this course.
MATH 244/CPSC 366 is a more advanced sequence, for students that are significantly more comfortable with or interested in the material. I would personally recommend this class if you have a fair of experience with contest math (particularly proof writing), as that is similar to what you’ll be doing in either track.

Applying for tech internships
Start preparing early!
A lot of tech companies recruit very early; most will open applications for summer internships by the fall of the preceding year. Furthermore, a lot of internship positions are hired on a rolling basis, so it's in your best interest to apply as early as possible. The recruiting process for an individual company may also take quite a few weeks and depend on the company's schedule, so applying early can help ensure that your timeline is more flexible.

Utilize the Yale Office of Career Strategy (OCS)
OCS has a lot of useful resources if you're planning on working in technology over the summer, such as resume workshops, career fairs, and networking events. Before applying to any company, it is important to have a focused and polished resume, and OCS offers both resume templates and one-on-one meetings in order to ensure that your resume is in good shape. Career fairs [any Yale links to these?] and networking events are extremely helpful for directly meeting recruiters from particular companies and getting your foot in the door.

Practice for coding interviews
Make sure you practice for coding interviews. Coding interviews usually come after an initial screening interview and consists of a couple of short questions in which you are asked to devise and implement an algorithm. Although this may be similar to what you've done in classes, it is important to practice in a timed environment, while talking through your thought process; that's what will be expected during the interview! It can be helpful to go through this process with a friend, with one person acting as the interviewer and one as the interviewee. A tried and true resource for preparing for coding interviews is *Cracking the Coding Interview*, by Gayle Laakmann McDowell, which contains a plethora of practice problems as well as general strategies for how to approach these types of problems.

Applying for tech internships
Start preparing early!
A lot of tech companies recruit very early; most will open applications for summer internships by the fall of the preceding year. Furthermore, a lot of internship positions are hired on a rolling basis, so it's in your best interest to apply as early as possible. The recruiting process for an individual company may also take quite a few weeks and depend on the company's schedule, so applying early can help ensure that your timeline is more flexible.

Utilize the Yale Office of Career Strategy (OCS)
OCS has a lot of useful resources if you're planning on working in technology over the summer, such as resume workshops, career fairs, and networking events. Before applying to any company, it is important to have a focused and polished resume, and OCS offers both resume templates and one-on-one meetings in order to ensure that your resume is in good shape. Career fairs [any Yale links to these?] and networking

events are extremely helpful for directly meeting recruiters from particular companies and getting your foot in the door.

Practice for coding interviews
Make sure you practice for coding interviews. Coding interviews usually come after an initial screening interview, and consists of a couple of short questions in which you are asked to devise and implement an algorithm. Although this may be similar to what you've done in classes, it is important to practice in a timed environment, while talking through your thought process; that's what will be expected during the interview! It can be helpful to go through this process with a friend, with one person acting as the interviewer and one as the interviewee. A tried and true resource for preparing for coding interviews is *Cracking the Coding Interview*, by Gayle Laakmann McDowell, which contains a plethora of practice problems as well as general strategies for how to approach these types of problems.

Strategies for Success
Talk to Upperclassmen
Many upperclassmen have been in the same position and felt the same way as you before, so don't hesitate to approach them for advice. This is a great way to learn more about anything and everything, including class recommendations, summer opportunities, and extracurricular activities. If you don't know any upperclassmen well enough, reach out to the Departmental Student Advisory Committee (DSAC); you can sign up for a coffee chat with one of their members, all of whom are extremely knowledgeable about the department. Students offer a different perspective on things compared to professors, so reach out and ask to grab a meal!

Go to Office Hours
Office hours are invaluable for computer science classes at Yale, whether you need to clarify an important concept, get help beginning with a problem set, or simply checking that you're on the right track. They are particularly helpful in introductory classes, many of which have large teams of staff ready to assist you. Try your best to go as early as possible – you don't want to be part of the frantic mob that inevitably appears the night before each problem set is due, for both the staff's sake as well as your own.

Work with Friends
Try to work with friends when you're completing a problem set or studying for an exam. Computer science is all about teamwork – having someone to talk things through with will make things easier and more fun. However, be mindful of each course's collaboration policy. Many follow Professor Eisenstat's Gilligan's Island rule: "When discussing an assignment with anyone other than the teaching staff, you may write on a board or a piece of paper, but you may not take any written or electronic record away from the discussion. Moreover, you must engage in a mind-numbing activity (e.g., watching an episode of Gilligan's Island) before you work on the assignment again." Finding people you enjoy working with will not only make your journey through the program much more enjoyable, but also prepare you for the collaborative mentality present in both academia and industry.

STEM Major Roadmaps

The Yale College Deans Office, in consultation with the Directors of Undergraduate Studies, has undertaken a project designed to help students compare majors and navigate their ways through them. They have created a series of very useful "roadmaps", https://registrar.yale.edu/students/major-roadmaps, or visual representations, guiding students through various majors. Many majors offer multiple paths, and the maps are designed to facilitate comparison. The roadmaps and typical course sequences are visually uniform so that students may easily compare one major with another at a glance. As a faculty advisor, I use them frequently.

The following pages are roadmaps for most of the STEM majors at Yale. Maps for the STEM majors that do not appear here are forthcoming.

Class of 2019 and prior

Biomedical Engineering

	BS Bioimaging Specialization	BS Biomechanics & Mechano-biology Specialization	BS Biomolecular Engineering Specialization	BS Systems Biology Specialization
Degrees Offered				
Prerequisites for entering the major	BIOL 101 and 102, or higher in MCDB or MB&B with DUS permission			
	CHEM 161 or higher and ENAS 194			
	MATH 115; 120 or ENAS 151; PHYS 180,181, 205L, and 206L (or 165L and 166L with DUS permission)			
Requirements for each degree	**12 term courses** totaling at least 11 course credits beyond prereqs			
	BENG 249, 350, 351, 352, 353, 355L, 356L			
	3 of following courses: BENG 404, 406, 410, 444, 445, 475, 476, 485	3 of following courses: MENG 185, 280, 361, BENG 404, 410, 434, 453, 455, 456, 457, 458	3 of following courses: BENG 404, 410, 411, 434, 435,463, 463, 464, 465, 467, MENG 361	3 of following courses: BENG 404, 410, 411, 434, 435,463, 463, 464, 465, 467, MENG 361
	2 term courses in life sciences from prereq and req courses			
Senior Requirements	**BENG 480 and Senior Project** (BENG 474 or BENG 473 and 474)			
Substitutions	Relevant course with DUS permission			

Class of 2020 and beyond

Biomedical Engineering

	BS Bioimaging Specialization	BS Biomechanics & Mechano-biology Specialization	BS Biomolecular Engineering Specialization	BS Systems Biology Specialization
Degrees Offered				
Prerequisites for entering the major	BIOL 101 and 102, or higher in MCDB or MB&B with DUS permission			
	CHEM 161 or higher and ENAS 194			
	MATH 115; 120 or ENAS 151; PHYS 180,181, 205L, and 206L (or 165L and 166L with DUS permission)			
Requirements for each degree	**13 term courses** totaling at least 11 course credits beyond prereqs			
	BENG 249, 280, 350, 351, 352, 353, 355L, 356L			
	3 of following courses: BENG 404, 406, 410, 444, 445, 475, 476, 485	3 of following courses: MENG 185, 280, 361, BENG 404, 410, 434, 453, 455, 456, 457, 458	3 of following courses: BENG 404, 410, 411, 434, 435,463, 463, 464, 465, 467, MENG 361	3 of following courses: BENG 404, 410, 411, 434, 435,463, 463, 464, 465, 467, MENG 361
	2 term courses in life sciences from prereq and req courses			
Senior Requirements	**BENG 480 and Senior Project** (BENG 474 or BENG 473 and 474)			
Substitutions	Relevant course with DUS permission			

Chemistry

	BA Chemistry	BS Chemistry	BS Chemistry (Intensive Major)	BS/MS Chemistry
Degrees Offered				
Prerequisites for entering the major	**General Chemistry I and II** (CHEM 161 and 165 or CHEM 163 and 167 CHEM 134L and 136L)			
	Integral Calculus (MATH 115)			
	Introductory Physics 170 or higher (PHYS 180, 200 or 260)			
Requirements for each degree	**10 credits** 11 courses	**13 credits** 14 Courses	**15 credits** 16 Courses	**Intensive + 4 grad courses**
	2 Semesters Organic Chemistry (with Labs) CHEM 174 or 220 and CHEM 175, 221, or 230. CHEM 222L and 223L			Application by end of 5th term
	Physical Chemistry (CHEM 332 or 328)	2 Physical Chemistry courses (with 1 Lab) (CHEM 332, 333 and 330L)		CHEM 490 during 5th/6th term
	lnorganic Chemistry CHEM 252			Research between Jr/Sr year
	N/A		PHYS 171, 181, 201, or 261	N/A
	4 Addtl course credits At least 1 lecture, 1 lab	5 Advanced course credits At least 2 lectures and 1 lab		
Senior Requirements	**Senior Seminar** CHEM 400	**2 Semesters Research** CHEM 490 or CHEM 400 + advanced additional course	**2 Semesters Research** CHEM 490	**4 Semesters Research** including 2 in CHEM 990
Substitutions	Up to 2 relevant advanced science courses in other departments for advanced chem courses			**N/A**

Four Possible Paths Through the Major in Chemistry

Possible BA Sequence

	Fall	*Spring*
Year 1	CHEM 161, 134L, & MATH pre-req	CHEM 165, 136L, & MATH pre-req
Year 2	CHEM 220, 222L, & PHYS pre-req	CHEM 221, 223L, & 252
Year 3	CHEM 332	CHEM 226L & 1 Elective
Year 4	CHEM 400 & 1 Elective	1 Elective

Possible Intensive Sequence

	Fall	*Spring*
Year 1	CHEM 163, 134L, & MATH pre-req	CHEM 167, 136L, & MATH pre-req
Year 2	CHEM 220, 222L, & PHYS pre-req	CHEM 221, 223L, 252, & PHYS pre-req
Year 3	CHEM 332 & 330L	CHEM 333, 226L, & 1 Elective
Year 4	CHEM 490 & 2 Electives	CHEM 490 & 1 Elective

Possible BS Sequence

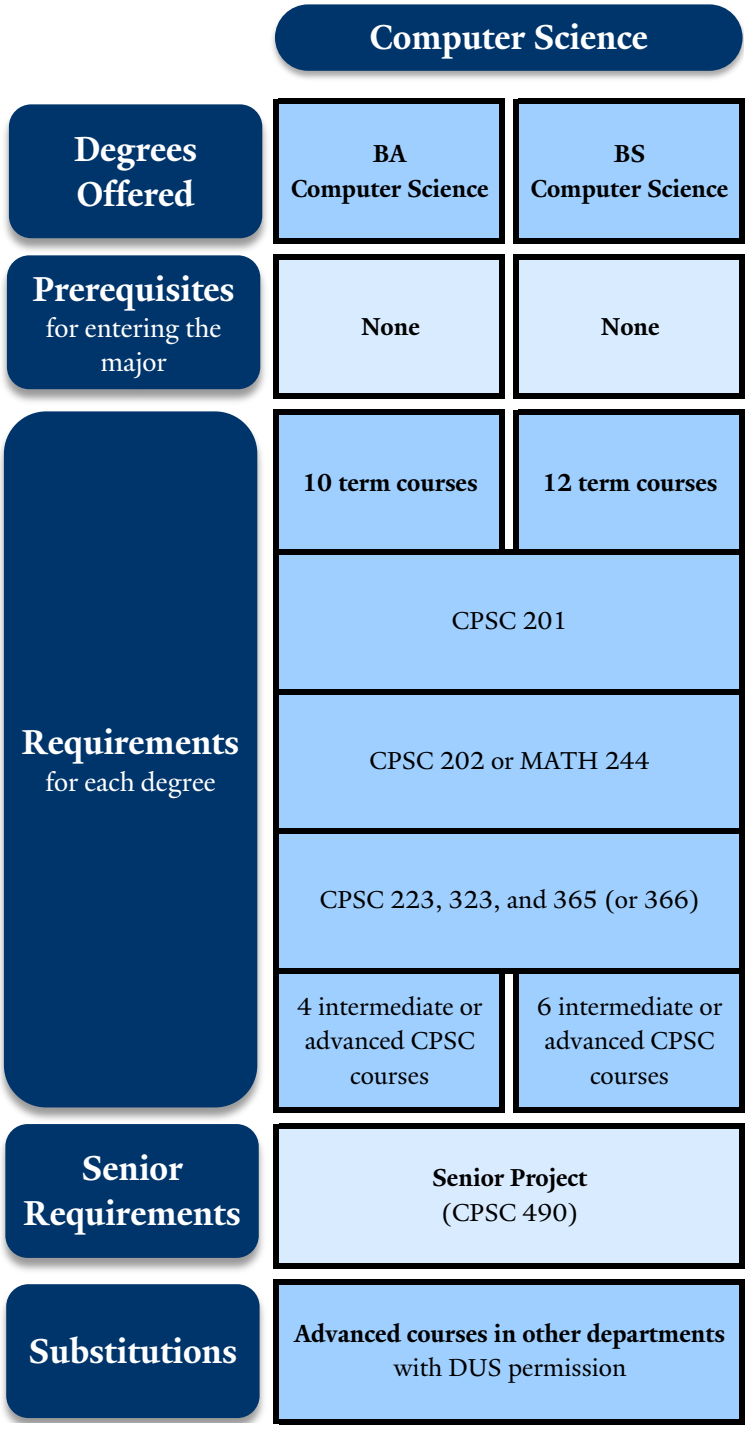
	Fall	*Spring*
Year 1	CHEM 161, 134L, & MATH pre-req	CHEM 165, 136L, & MATH pre-req
Year 2	CHEM 220, 222L, & PHYS pre-req	CHEM 221, 223L, & 252
Year 3	CHEM 332 & 330L	CHEM 333, 252, & 251L
Year 4	CHEM 490 & 2 Electives	CHEM 490 & 1 Elective

Possible BS/MS Sequence

	Fall	*Spring*
Year 1	CHEM 174, 222L, MATH & PHYS pre-req	CHEM 175, 223L, MATH & PHYS pre-req
Year 2	CHEM 330L & 332	CHEM 333, 252, & 251L
Year 3	CHEM 490 & 2 Electives	CHEM 490 & 2 Electives
Year 4	CHEM 990 & 2 Electives	CHEM 990 & 2 Electives

Cognitive Science

Degrees Offered	**BA**	**BS**
Prerequisites for entering the major	CGCS 110	
Requirements for each degree	**14 term courses,** for a total of 13.5 course credits (including prereq and senior req)	
	CGSC 395	
	1 course from 4 of the following six areas: Computer Science (CPSC 201) Economics and Decision Making (ECON 159) Linguistics (Ling 10, 116 217, 130, 232, 253) Neuroscience (CGSC 201, MCDB 320, PSYC 160 or 270) Philosophy (Phil 126, 182, 269, 270, 271) Psychology (PSYC 110, 140, 139)	
	6 courses in a specific topic or area	
	1 skills course (CPSC 112 or 202, Ling 224, PSYC 200 or 270)	1 skills course (PSYC 200, or another course with DUS permission)
Senior Requirements	CGSC 491 (Nonempirical senior essay)	CGSC 491 (Empirical research and senior essay)


Computer Science
Degrees Offered
BA Computer Science
BS Computer Science
Prerequisites for entering the major
None
None
Requirements for each degree
10 term courses
12 term courses
CPSC 201
CPSC 202 or MATH 244
CPSC 223, 323, and 365 (or 366)
4 intermediate or advanced CPSC courses
6 intermediate or advanced CPSC courses
Senior Requirements
Senior Project (CPSC 490)
Substitutions
Advanced courses in other departments with DUS permission

Four Possible Paths Through the Major in Computer Science

CPSC BA

	Fall	*Spring*
Year 1	CPSC 201	CPSC 223
Year 2	CPSC 202 (or MATH 244) & CPSC 323	CPSC 365 (or 366) & 1 Elective
Year 3	1 Elective	1 Elective
Year 4	CPSC 490	1 Elective

CPSC BA Soph Start

	Fall	*Spring*
Year 1		
Year 2	CPSC 201	CPSC 202 (or MATH 244) & CPSC 223
Year 3	CPSC 323 & 1 Elective	CPSC 365 (or 366) & 1 Elective
Year 4	CPSC 490 & 1 Elective	1 Elective

CPSC BS

	Fall	*Spring*
Year 1	CPSC 201	CPSC 223
Year 2	CPSC 202 (or MATH 244) & CPSC 323	CPSC 365 (or 366) & 1 Elective
Year 3	2 Electives	2 Electives
Year 4	CPSC 490	1 Elective

CPSC BS Soph Start

	Fall	*Spring*
Year 1		
Year 2	CPSC 201	CPSC 202 (or MATH 244) & CPSC 223
Year 3	CPSC 323 & 1 Elective	CPSC 365 (or 366) & 1 Elective
Year 4	CPSC 490 & 2 Electives	2 Electives

Ecology and Evolutionary Biology

	BA Ecology and Evolutionary Biology (Track 1)	BA Ecology and Evolutionary Biology (Track 2)	BS Ecology and Evolutionary Biology
Degrees Offered			
Prerequisites for entering the major	**Intro Biology sequence** (BIOL 101, 102, 103, and 104) **2 term lecture in general Chemistry** (CHEM 161, 165 or CHEM 163, 167) with labs (CHEM 134L, 136L) **1 term organic Chemistry** CHEM 174 or 175, or CHEM 220 or 221) with lab (CHEM 222L or 223L) **2 terms Physics** (PHYS 170, 171, or higher) **1 term Mathematics** MATH 115 or higher or S&SD 101-106		
Requirements for each degree	**3.5 course credits** (not incl senior req)	**3.5 course credits** (not incl senior req)	**5.5 course credits** (not incl senior req)
	E&EB 220	E&EB 290 and E&EB 295 or BENG 350 and MCDB 300	BA requirements in either track
	E&EB 225		2 elective courses, one must be lecture, other can be seminar or labs (>200 level)
	1 course from E&EB 246-272, with lab	E&EB 291L	
Senior Requirements	**1 term independent study** (E&EB 470) **or** **Senior Essay**		**1 or 2 terms original research** (E&EB 475-476, 495-496)
Substitutions	Two upper-level courses in G&G (excluding paleobiology courses), MATH, CPSC, or ENAS for organic chem and lab. Second term of organic chem and lab and up to two terms of physics labs allowed as electives. Courses from other departments may also be suitable as electives. All substitutions require permission of the DUS		

Environmental Studies

BA Environmental Studies	Degrees Offered	BS Environmental Studies
None	**Prerequisites** for entering the major	**1 course from EVST 202L, 221, 234L, 244, 290, 362, or G&G 126L**
		MATH 112 or above (excl MATH190) **or PHYS 170 or above or S&DS 101 or above**
		2 term lecture sequence in chemistry or CHEM 170 or 167
		2 terms from BIOL 101 and 102 or BIOL 103 and 104 or G&G 125 or MCDB 123
13 course credits (incl senior project)	**Requirements** for each degree	**12 course credits,** (beyond prereqs, incl senior project)
6 core courses, of which at least: 1 course in statistics or mathematics (S&DS 101 or above, or MATH 112 or above) and 2 humanities and social sciences courses (EVST 120, 226, 255, 340, or 345) and 2 natural sciences courses, with Sc designation (EVST 191, 200, 223, 242; E&EB 115 or 145; G&G 120 or 140; G&G 125 or MCDB 123; CHEM 161 or 165; EVST 202L, 221, 234L, 244, 290, 362, or G&G 126L; or CDE 508)		2 core courses in the humanities or social sciences (EVST 120, 226, 255, 340, or 345)
		2 natural science core courses (EVST 200, 223, 242, or G&G 140)
6 courses in concentration, of which at least: 1 adv seminar (200 level or higher) that exposes students to primary literature, extensive writing requirements, and experience with research methods		6 courses in concentration, of which at least: 1 adv seminar (200 level or higher) that exposes students to primary literature, extensive writing requirements, and experience with research methods and 3 courses with Sc designation and 2 courses that provide interdisciplinary context
One or two-term research project and colloquium (EVST 496)	**Senior Requirements**	**Two-term research project and colloquium** (EVST 496)

History of Science and Medicine

Degrees Offered	**BA** **History of Science, Medicine, and Public Health**
Prerequisites for entering the major	**None**
Requirements for each degree	**12 course credits** (including senior req)
	7 courses in pathway: 2 HSHM courses 1 seminar in HSHM or HIST (100 or higher) 3 electives from any dep (approved by faculty advisor) 1 science course (approved by faculty advisor)
	3 additional HSHM electives, including 1 seminar and 1 course outside major pathway
Senior Requirements	**Yearlong project** (HSHM 490, 491) ***or*** **One term project** (HSHM 492) **and 1 additional HSHM elective**

Three Possible Paths Through the Major in History of Science, Medicine, and Public Health

First-year Start, Preference for Seminars

	Fall	*Spring*
Year 1	HSHM First-Year Seminar	HSHM Lecture
Year 2	Pathway Elective	HSHM Seminar (in pathway)
Year 3	HSHM Seminar (not in pathway); HSHM Lecture (in pathway)	History Seminar (in pathway); Pathway Elective
Year 4	Senior Project (HSHM 490); Pathway Elective (SC course)	Senior Project (HSHM 491); Pathway Elective

Sophomore Start, Junior Year Abroad

	Fall	*Spring*
Year 1	N/A	N/A
Year 2	HSHM Lecture	HSHM Lecture (in pathway); HSHM Seminar (in pathway)
Year 3	Pathway Elective (abroad)	Pathway Elective (abroad); Pathway Elective (SC course, abroad)
Year 4	Senior Project (HSHM 490); HSHM Seminar; HSHM Lecture (not in pathway)	Senior Project (HSHM 491); HSHM Lecture (in pathway); Pathway Elective

Junior Start, Double Major

	Fall	*Spring*
Year 1	N/A	N/A
Year 2	N/A	N/A
Year 3	HSHM Seminar; Pathway Elective (SC course); Pathway Elective (in other major)	HSHM Lecture (in pathway); HSHM Lecture (not in pathway); Pathway Elective
Year 4	Senior Project (HSHM 490); HSHM Seminar (in pathway); Pathway Elective (in other major)	Senior Project (HSHM 491); HSHM Lecture (in pathway); HSHM Course

Mathematics

Degrees Offered	**BA** **Mathematics**	**BS** **Mathematics**
Prerequisites for entering the major	MATH 120 or equivalent (e.g. completing MATH 231)	
Requirements for each degree	**10 term courses** numbered 222 or higher	**10 term courses** numbered 222 or higher, **and 2 addtl adv courses** in physical sciences approved by DUS
	MATH 230 and 231 or MATH 222 or 225 and MATH 250	
	2 courses in each of 3 categories chosen from: Analysis Algebra and Number Theory Statistics and Applied Mathematics Geometry and Topology Logic and Foundations	
	Courses from at least 2 of 3 core areas: Algebra, Real Analysis, and Complex Analysis (One course may count towards one core area and one category. Core area and category designations for each course are listed in OCI)	
Senior Requirements	Senior Seminar (MATH 480) or Senior Essay (MATH 475) and oral report, with DUS permission	
Intensive Major	Courses in all 3 core areas; 2 MATH grad courses or equivalent independent study counted among the required courses	
Substitutions Permitted	Certain courses in Applied Mathematics, Computer Science, Engineering & Applied Science, Economics, Philosophy, Physics, Statistics & Data Science, or other departments, with DUS permission	

Mechanical Engineering

	BS Mechanical Engineering	BS Engineering Sciences (Mechanical)	BA Engineering Sciences (Mechanical)
Degrees Offered			
Prerequisites for entering the major	MATH 112 and 115		
	PHYS 180 and 181 or 200 and 201		PHYS 170 and 171
	ENAS 151 or equivalent		
	2 labs: 1 from PHYS 165L or 205L 1 from PHYS 166L or 206L, or equivalents	2 labs: 1 from PHYS 165L or 205L 1 from PHYS 166L or 206L, or MENG 286L	
Requirements for each degree	**21 term courses** beyond prereqs (incl senior req)	**12 term courses** beyond prereqs (incl senior project)	**8 term courses** beyond prereqs (incl senior req)
	ENAS 130 and 194		
	EENG 200		
	MATH 222 or 225		
	MENG 185, 211, 280, 285, 286L, 325, 361, 363L, 383, 389, 390		
	3 technical electives chosen in concultation with DUS (only one of MENG 471, 472, 473, or 474)		
	1 term course in chemistry numbered CHEM 161 or higher		
Senior Requirements	**MENG487L and MENG 488L** (taken in senior year)	**MENG 404; MENG 471, 472, 473, or 474; MENG 487L and 488L; MENG489;** or another upper-level design course chosen in consultation with DUS	**MENG 471, 472, 473, or 474;** or another upper-level design course chosen in consultation with DUS
Substitutions	Relevant course with DUS permission		

Molecular Biophysics and Biochemistry

Degrees Offered	**BA** Molecular Biophysics and Biochemistry	**BS** Molecular Biophysics and Biochemistry	**BS/MS** Molecular Biophysics and Biochemistry
Prerequisites for entering the major	**Two terms of General Chemistry with lab**		
	Intoductory Biology BIOL 101, 102, 103, and 104		
	Two terms of Calculus MATH 112, 115, or 116		
	One term of Organic Chemistry with lab		
Requirements for each degree	**11 courses** (including senior req)	**13 courses** (including senior req)	**12.5 courses** (including senior req) **and 8 graduate courses**
	Core Biochemistry and Biophysics Courses MB&B 251L, 300, 301, and 302		
	Second term of Organic Chemistry with lab and One term of Physical Chemistry		
	Two terms of Physics numbered PHYS 170 or higher		
	1 MB&B elective and 1 QR elective	2 MB&B electives, 1 QR elective, and 1 Science elective	
Senior Requirements	**Senior Project** (MB&B 490)		**Intensive Research** (MB&B 570a and MB&B 571b)

Class of 2020 and prior

Molecular, Cellular, and Developmental Biology

	BA	BS	BS Intensive	BS/MS
Degrees Offered				
Prerequisites for entering the major	BIOL 101, 102, 103, and 104			
	1 term MATH 115 or higher			
	3 terms in CHEM or PHYS	2 term lecture sequence in CHEM + 2 Labs		
		2 terms PHYS		
		1 term Organic CHEM + 1 Lab		
Requirements for each degree	**5.5 Course Credits** beyond prereqs	**9 Course Credits** beyond prereqs	**11 Course Credits** beyond prereqs	**11 Course Credits** beyond prereqs **+ 6 Grad Credits** (consult DUS)
	2 courses from MCDB 200, 202, 205, 210, 290, 300 (or MBB 300), 310, 320, 430	3 courses from MCDB 200, 202, 205, 210, 290, 300 (or MBB 300), 310, 320, 430		
	1 Bioscience Lab	2 MCDB Labs		
	2 General Electives from core courses or upper level MCDB courses			
	1 Special Elective from MCDB 350 or higher			
Senior Requirements	**Senior Essay or 1 term MCDB 475**	**MCDB 485/486 or 2 terms MCDB 475**	**MCDB 495/496**	**MCDB 585 (jr. spring) MCDB 595/596 (sr. year)**
Special Track Requirements	**Biotechnology**: MCDB 370; 1 elective from MCDB 350 or higher; 1 elective from MB&B 420, 443, BENG 351, 352, 410, 435, CENG 210, 411, CPSC 437, 445, 470, or 475.			
	Neurobiology: MCDB 320; 1 elective from MCDB 350 or higher; 1 elective from BENG 410, CPSC 475, 310, 315 415, 430, MCDB 361, PSYC 270, S&DS 101.			
	Quantitative Biology: MCDB 330; 1 elective from MCDB 350 or higher; 1 elective from MCDB 320, 361, 461, MB&B 302, 435, 452, 523, PHYS 402, MATH 246, or CPSC 475; 2 labs numbered MCDB 201L or above.			

Class of 2021 and beyond

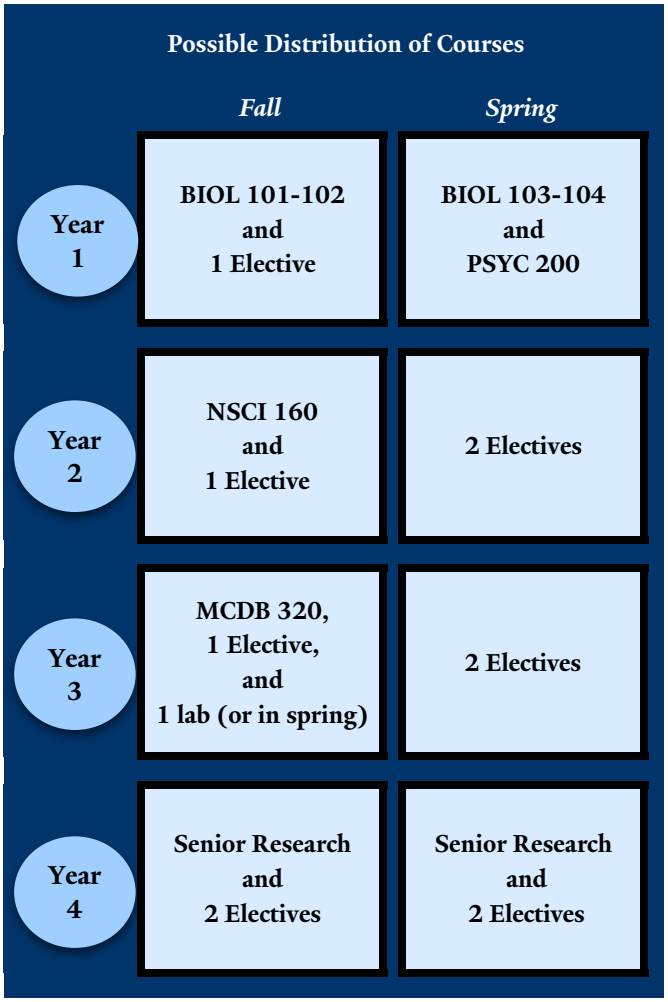
Molecular, Cellular, and Developmental Biology

	BA	BS	BS Intensive	BS/MS
Degrees Offered				
Prerequisites for entering the major	BIOL 101, 102, 103, and 104			
	1 course in MATH 115 or higher			
	2 term lecture sequence in CHEM			
	1 course in PHYS 170 or higher	2 courses in PHYS 170 or higher		
		1 course in Organic CHEM		
Requirements for each degree	**5.5 Course Credits** beyond prereqs	**9 Course Credits** beyond prereqs	**11 Course Credits** beyond prereqs	**11 Course Credits** beyond prereqs **+ 6 Grad Credits** (consult DUS)
	2 courses from MCDB 200, 202, 205, 210, 300 (or MBB 300)	3 courses from MCDB 200, 202, 205, 210, 300 (or MBB 300)		
	1 Bioscience Lab	2 MCDB Labs		
	2 General Electives from core courses or upper level MCDB courses (MCDB 250 and above)			
	1 Special Elective from MCDB 350 or higher			
Senior Requirements	**Senior Essay or 1 term MCDB 475**	**MCDB 485/486 or 2 terms MCDB 475**	**MCDB 495/496**	**MCDB 585 (jr. spring) MCDB 595/596 (sr. year)**
Special Track Requirements	**Biotechnology**: MCDB 370; 1 elective from MCDB 350 or higher; 1 elective from MB&B 420, 443, BENG 351, 352, 410, 435, CENG 210, 411, CPSC 437, 445, 470, or 475.			
	Neurobiology: MCDB 320; 1 elective from MCDB 350 or higher; 1 elective from BENG 410, CPSC 475, 310, 315 415, 430, MCDB 361, PSYC 270, S&DS 101.			
	Quantitative Biology: MCDB 330; 1 elective from MCDB 350 or higher; 1 elective from MCDB 320, 361, 461, MB&B 302, 435, 452, 523, PHYS 402, MATH 246, or CPSC 475; 2 labs numbered MCDB 201L or above.			

Neuroscience

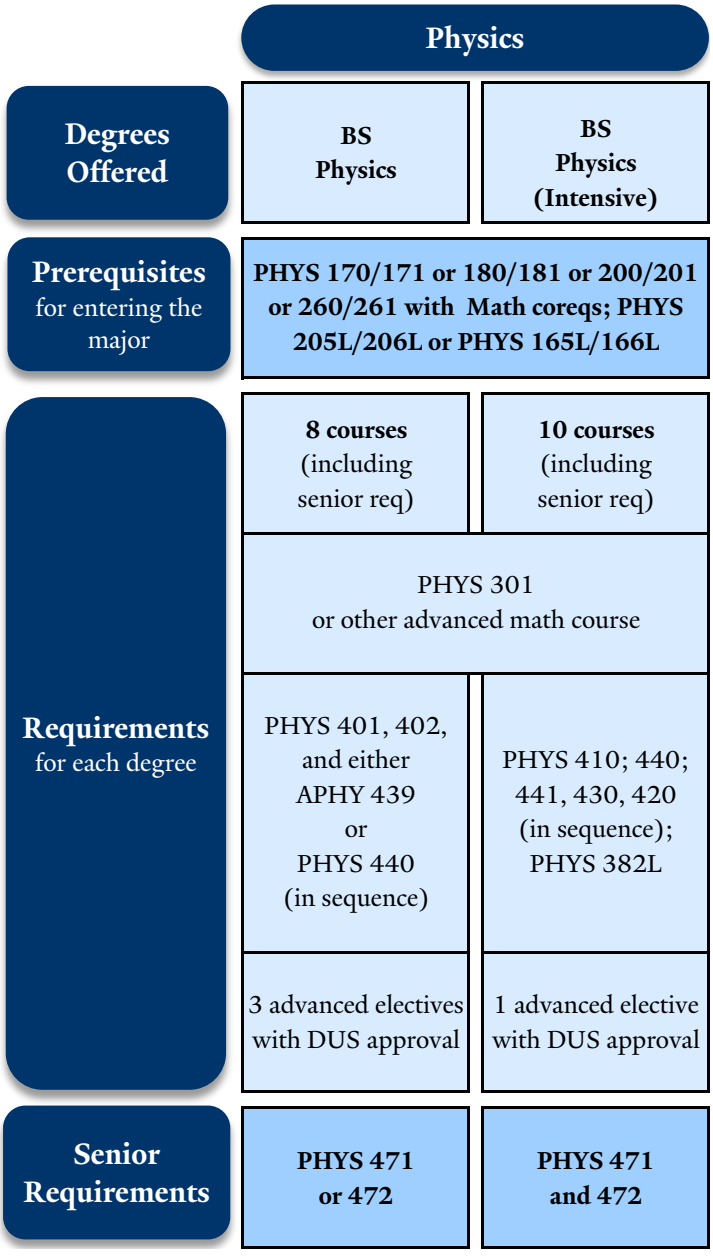
Degrees Offered	**BS**
Prerequisites for entering the major	**BIOL 101, 102, 103, and 104**
	One of S&DS 103, 105, 262, or PSYC 200
Requirements for each degree	**18.5 courses** (including senior req)
	NSCI 160 and **NCSI 320**
	1 lab course
	11 electives, including at least: 2 systems/circuits/behavior core courses 2 molecular/cellular/biological core courses 1 quantitative core course 1 basic allied core course 1 adv allied core course (no more than 2 other allied core courses)
Senior Requirements	**2 courses in empirical research** (non-empirical may be substituted for one or both terms for a BA degree)

Possible Paths Through the Major in Neuroscience

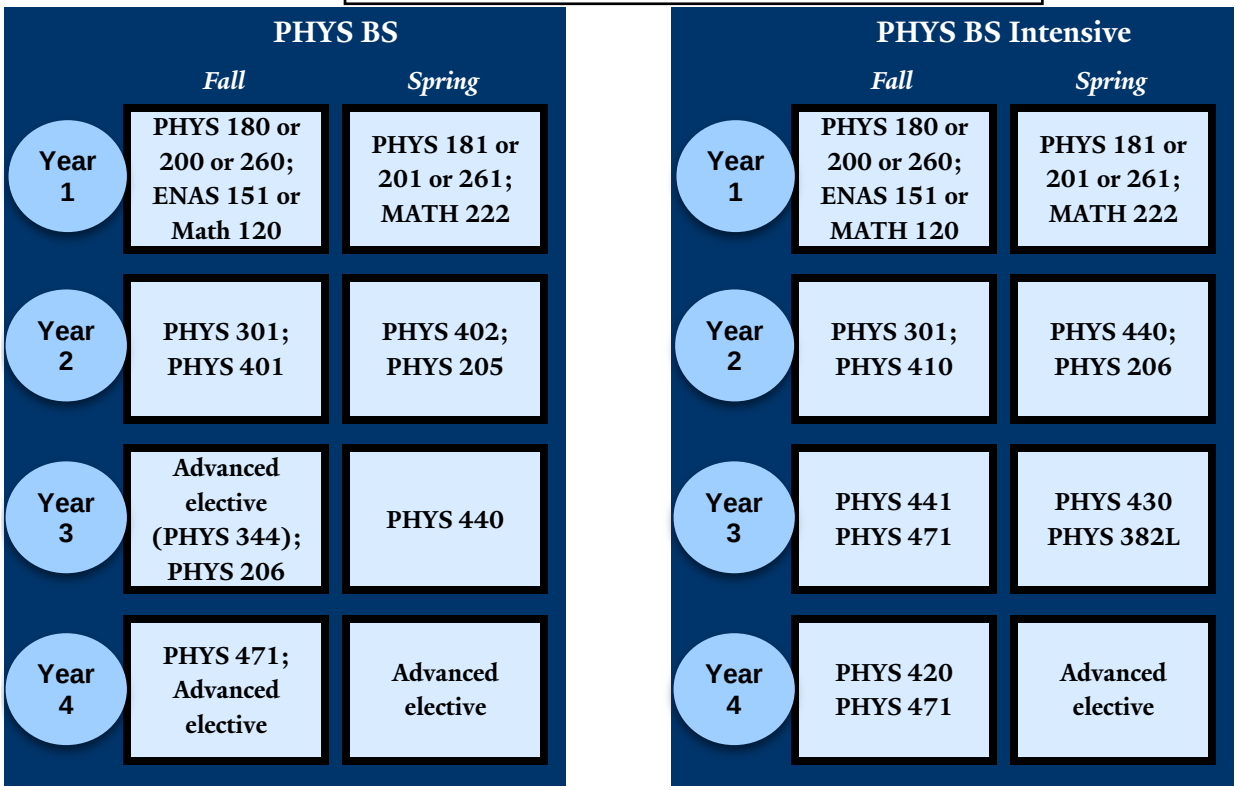


Potential Electives by Emphasis

Elective pool	Quantitative	Systems/Cognitive	Cellular/Molecular	Premed
Stats Prereq (1)	S&DS 238 or 262	PSYC 200	S&DS 105	S&DS 105
Lab course (0.5 or 1)	NSCI 258	NSCI 240	NSCI 321L	NSCI 321L
Circuits and Systems (2+)	NSCI 340 NSCI 442	NSCI 340 NSCI 341 NSCI 352 NSCI 355 NSCI 360 NSCI 442	NSCI 340 NSCI 341	NSCI 340 or 352 NSCI 360
Molecular and Cellular (2+)	NSCI 324 or 325 MCDB 310	MCDB 202 MCDB 205 or 210	MCDB 200 MCDB 205 MCDB 300 or MB&B 300 MCDB 202 or 210	MCDB 205 MCDB 300 or MB&B 300
Quantitative (1+)	MATH 120 MATH 225 MATH 246	MATH 112 or 115	MATH 115 or 120	MATH 115 or 116
Basic Allied (1+)	PHYS 180	PHYS 170	CHEM 161 CHEM 165 CHEM 174	CHEM 161 CHEM 165 CHEM 174 PHYS 170 PHYS 171
Advanced Allied (1+)	CPSC 112 CPSC 475 BENG 445 or S&DS 361	CPSC 100 or 112	CPSC 112	CPSC 100 or 112


Physics
Degrees Offered
BS Physics
BS Physics (Intensive)
Prerequisites for entering the major
PHYS 170/171 or 180/181 or 200/201 or 260/261 with Math coreqs; PHYS 205L/206L or PHYS 165L/166L
Requirements for each degree
8 courses (including senior req)
10 courses (including senior req)
PHYS 301 or other advanced math course
PHYS 401, 402, and either APHY 439 or PHYS 440 (in sequence)
PHYS 410; 440; 441, 430, 420 (in sequence); PHYS 382L
3 advanced electives with DUS approval
1 advanced elective with DUS approval
Senior Requirements
PHYS 471 or 472
PHYS 471 and 472

Two Possible Paths Through the Major in Physics



Statistics & Data Science

Degrees Offered	**BA**	**BS**
Prerequisites for entering the major	MATH 120, ENAS 151, MATH 230 or equivalent	
Requirements for each degree	**11 term courses** beyond prereqs, incl senior req	**14 term courses** beyond prereqs, incl senior req
	MATH 222 or 225	
	2 courses from Core Probablity and Statistics	
	2 courses from Computational Skills	
	2 courses from Methods of Data Science	
	3 Electives chosen from any discipline area with DUS approval	
		S&DS 242
		2 additional Electives from any discipline except Data Science in Context and Methods in Application Areas, with DUS approval
Senior Requirements	**Senior Seminar** (S&DS 490) **or** **Senior Project** (S&DS 491 or 492) **or** **Statistical Case Studies** (S&DS 425)	