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About the cover: The cover is meant to illustrate the perpetual development and focus of chemistry research at Harvard and in general. From acknowledging the beauty of synthesizing complicated organic molecules and treating them as the end-goal, to today merging erstwhile disparate fields – such as molecular biology and inorganic chemistry – to tackle pertinent human issues. The intricately complex small molecule B\(_{12}\) was first synthesized in 1973 by a substantial collaboration led by Harvard’s R.B. Woodward. It serves as an apogee of meticulous organic synthesis. The iron-based polynuclear complex, synthesized in Professor Betley’s lab, is an example of an inorganic system that can potentially elucidate how nature activates small molecules, or how to make molecules even more reactive than a biological process.\(^1\)

\(^1\) Powers, Fout, Zheng, Betley. JACS 2011, 133, 3336.
Dear future science concentrator,

We hope that you’re enjoying your time discovering where all of the buildings are, trying to find the shortest paths to each destination in seven minutes\(^2\), exploring Harvard Square, etc. Unfortunately, there is also a lot of schoolwork to think about, which is why we’ve put together this handy guide for you.

Here, you will find information ranging from whom to talk to about a potential concentration\(^3\), student perspectives on classes in the biology, chemistry, and physics departments, student groups you may want to consider joining, and information about research (for later consideration). We intended this guide as a handy reference, for use now or even during your senior year. This guide has been written entirely by upperclassmen and we’ve also included bits that we learned from upperclassmen when we were freshmen ourselves. We’ll even let you in on some of the lingo used here at Harvard— hence the footnotes. You’ll catch on in no time what WISHR, TF, and PI stand for\(^4\). As the year progresses, come visit us at our Harvard Chemistry Club socials and events with professors. We’d love to hear about how your explorations have been going!

We wish you the best for your first year at Harvard!

With love,

Harvard Chemistry Club

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\(^2\) In case you’re wondering, the seven-minute rule correlates with the amount of time students get to walk between classes. A class that is supposed to start on the hour usually starts seven minutes later. Hence, everyone starts to be late for everything, including extracurricular meetings, seeing friends, catching the bus... Why seven you ask? Who knows, maybe the administration wanted good luck or something.

\(^3\) Yup, these are the equivalent of majors at other universities. Don’t let anyone catch you calling them majors now...people might pretend they don’t know you.

\(^4\) Answers may be found throughout this guide.
§0 Introduction

The Secret of Life: Or, at least, of studying science at Harvard

The venerable Chris Rock once said, “Sometimes, I just like to steal.” In that spirit of brutal honesty and unchecked adventurism, we, the Harvard Chemistry Club, present you with an insider’s guide to finding out all the best science resources at Harvard.

Now that you’re finally here, after an intense application process and months of waiting, you may have already realized that sometimes Harvard can be a quite difficult place to navigate. Annenberg is Hell cleverly disguised as Hogwarts; the Union dorms are ridiculously far from all classes; and though you may have told your friends you go to school in Boston, you probably will only go to the city a handful of times this year. Nonetheless, one thing that Harvard is exceptionally good at – among a lot of other things I have to admit – is providing their students with a ton of valuable resources, especially for students studying the sciences.

As an incoming freshman, one of your primary concerns is probably deciding which introductory science classes to take. This requires some research so as not to take a course that is too advanced or a course that will be a humdrum repetition of high school science. Undoubtedly, the best resources for trying to determine which classes are a good fit and for thinking about potential concentrations are faculty members known as the concentration advisors.

§1 Science Resources

The parsing of science concentrations is a perpetually changing landscape reflecting the growth and state of the scientific disciplines. While we’ve tried to provide as much information about the new concentration structure in this booklet, we urge you to schedule meetings with concentration advisors if you have more questions. Check out the department websites for more useful info and contacts.

§1.1 Concentrations

Chemistry
Prof. Daniel Kahne, Director of Undergraduate Studies
kahne@chemistry.harvard.edu
(617) 496-0208
Dr. Gregg Tucci, Co-Director of Undergraduate Studies
tucci@fas.harvard.edu
(617) 496-4668
Science Center 114

Dr. Tucci is the academic advisor for all chemistry majors. He is the go-to man for understanding the ins and outs of chemistry courses at Harvard and for helping you decide which class is best for you. If you’re considering research as well, Dr. Tucci is more than willing to advise you on how to approach research at Harvard. Dr. Tucci is also just a great guy to know; he is incredibly willing to help students and is extremely nice. And he knows how to bake a mean peach pie\(^5\).

**Chemical and Physical Biology (CPB)**

Martin Samuels, Assistant Director of Undergraduate Studies
msamuels@fas.harvard.edu
(617) 496-1206

Professor Adam Cohen, Co-Head Tutor
cpbconc@lsdiv.harvard.edu
(617) 496-9466

Professor Rachelle Gaudet, Co-Head Tutor
gaudet@mcb.harvard.edu
(617) 495-5616

CPB is the right option for students who are interested in applying chemical, physical, and mathematical tools to probe and study biological systems.

**Chemistry and Physics**

Professor Howard Georgi
georgi@physics.harvard.edu
(617) 496-8293

The chemistry and physics concentration is strong preparation for graduate research in physical sciences, one of the many future paths available. While it consists of more requirements than chemistry, it is not too difficult to switch between the two concentrations, as long as you take the Physics 15 sequence (see §2.4).

**Molecular and Cellular Biology**

Professor Vlad Denic, Co-Head Tutor
vdenic@mcb.harvard.edu

\(^5\) Recipient of the 2006 Derek Bok Center Golden Spatula Award for best beach pie.
MCB is intended for students who are interested in pursuing careers in cellular biology research or medicine and for those who wish to combine interests in chemistry, physics, and math through the study of cellular processes.

**Integrative Biology (formerly Organismic and Evolutionary Biology)**
Professor Gonzalo Gribet, Head Tutor
ggiribet@g.harvard.edu
(617) 495-1473

Dr. Andrew Berry, Assistant Head Tutor
berry@oeb.harvard.edu

IB is an interdisciplinary concentration that prepares its students to ask fundamental questions about the origin and function of organisms as well as interaction between organisms in an ecosystem. Thus, more than the other life science concentrations, IB requires its students to take a significant amount of biology. In addition, IB makes available to its concentrators many facilities and opportunities, such as the Harvard Forest, the Botanical Museum, greenhouses, an electron microscope, and DNA sequencing facilities.

**Physics**
Professor Howard Georgi
georgi@physics.harvard.edu
(617) 496-8293
Jefferson 456 (behind the Science Center)

Physics is for students who are interested in studying the way the world works, from the big bang to the bizarre relativistic and quantum mechanical regime of objects. Physics concentrators are required to take a reasonably small number of courses, and this makes the concentration very flexible, and many students choose joint concentrations such as Physics-Mathematics, Physics-Astronomy, and Physics-History of Science. Additional flexibility is provided by the Physics options in Biophysics, Applied Physics, and Teaching.

§1.2 Student Academic Groups
Alright, so you’ve gotten a chance to talk to people who can help you decide on classes and maybe have even start thinking about possible concentrations. So now what should you do?

A great way to meet people who share your interests is to learn more and possibly join some of Harvard’s many, many student groups. Since this booklet is supposed to help guide you academically, we’ll just briefly talk about a few student academic groups.

**Harvard Chemistry Club**
We sponsor guest lectures, faculty dinners, a research symposium in the spring, and have social events. We are working to become more involved in advising, and are an organized but informal way to find out whatever it is you want to know about chemistry at Harvard. From questions about joining labs, to coursework, to post-graduation plans, the students in the Chemistry Club are here to help. By joining the Chemistry Club, you will receive informational emails about the happenings in the department and any special events we may be hosting. To find out more about us, visit: [http://www.hcs.harvard.edu/chemclub/](http://www.hcs.harvard.edu/chemclub/)

**Society of Physics Students**
The Goliath among student science organizations, the Society of Physics Students (SPS) boasts a huge membership. They have weekly meetings lunches with speakers, organize a buddy system to help incoming students interested in physics, host social events, and direct a variety of other activities. To learn more: [http://www.hcs.harvard.edu/~physics/](http://www.hcs.harvard.edu/~physics/)

**Women in Science at Harvard-Radcliffe (WISHR)**
WISHR is a student run organization that addresses the needs and issues—academic, social, and political—that most concern undergraduate women in science at Harvard College. In addition, the organization seeks to develop a sense of community among undergraduate women in science at Harvard. WISHR sponsors academic and career programs as well as has a mentoring network with women at the graduate school or professional level. For more information: [http://wishr.weebly.com](http://wishr.weebly.com)

**Harvard University Biological Sciences Society (HUBSS)**
The Harvard Undergraduate Biological Sciences Society (HUBSS) seeks to serve the club community, the Harvard community, and the greater public community in advancing the study of biology and building a support network for those interested in the biological sciences. HUBSS seeks to provide excellent advising and mentoring for students, to create a forum of exchange between students, to applaud the work of scientists
(both faculty and students) while stimulating interest among younger students, and to increase the public’s understanding of biology. HUBSS strives to centralize the many resources at Harvard for the optimal experience and maximal success of each student interested in the biological sciences. For more information visit: http://www.hcs.harvard.edu/hubss/

**Environmental Action Committee**
The Environmental Action Committee (EAC) is a student organization that promotes sustainability and all-around environmental consciousness for the Harvard community. They have a significant political influence on campus and are devoted to promoting the achievement of environmental goals through student and local government. They also organize several trips into the untamed wilderness of Massachusetts and nearby states. Their website is: [http://www.hcs.harvard.edu/~eac/](http://www.hcs.harvard.edu/~eac/)

**Harvard Society for Mind, Brain, and Behavior**
Formed in 2002, the Harvard Society for Mind, Brain, and Behavior (HSMBB) offers students interested in MBB tracks a forum to talk more about their academic interests, as well as learn more about MBB in different fields. This society is most relevant to those concentrating in neurobiology, psychology, philosophy, computer science, history of science, biological anthropology, and linguistics. However, they welcome the opportunity to share the growing field of MBB to all. This society hosts guest lectures, CommuniTea informal conversations, two symposia per year, and social events. To learn more about HSMBB, please visit: [http://www.hcs.harvard.edu/~hsmbb/](http://www.hcs.harvard.edu/~hsmbb/)

### §1.3 Academic Resources

Once you begin the school year and find yourself deluged by more work than you could have previously imagined, it is really important that you be able to find help when you need it. To this end, there are several offices and places you can go for academic counseling, advice and tutoring.

**Bureau of Study Counsel**

http://bsc.harvard.edu/
(617) 495-2581
5 Linden St. (get into the Square on Mass. Ave. Go towards Toscanini’s Ice Cream and you will see Linden St. Turn right and you will soon see the building on your right.)
The Bureau is an invaluable resource for Harvard students. One of their main responsibilities is to hold workshops and lessons in how to study, more effective reading strategies, better time-management skills, etc. They also run a tutor system in which you may request for a tutor in almost any class if you feel you would like some help. The tutors themselves are Harvard students who have already taken the class you’re taking and did quite well. On your part, you only have to pay $4/hr for tutors; the remainder of the cost is subsidized by the Bureau.

**Loker Commons Math Tables**
Sunday through Thursday nights, Math CAs staff tables in Loker Commons (underneath Annenberg) to discuss the homework and concepts from class. The tables are very well attended and really helpful if you’re having difficulty or just want to get a better grasp of the material

**Professors and Teaching Fellows**
Though it may seem intimidating, visiting professors during their office hours isn’t nearly as bad as it seems. Many professors are often very glad to speak with you about concerns and questions you may have with the course material. In addition, office hours are a great time to get to know a professor and his/her area of research a little better. A note though: do come prepared with actual questions and specific points on which you need clarification. Also, it is always good to be able to know something about what the professor likes outside of the classroom, as a transition towards talking about their research and possible job opportunities. For example, did you know that Prof. David Liu, who teaches Life Sciences 1a, is a ridiculously good card player? As in he is banned from certain Vegas casinos because he wins too much.

**Student Opinion: Getting to know Professors**
Developing relationships with Professors will give you a sense of where the respective research field is headed and what it takes to do truly innovative work. Their passion will motivate you and the interactions will enrich your undergrad experience. Take full advantage of office hours and the opportunities you will have to invite a Professor to dinner.

- David Jaramillo, Chemistry ‘16

Teaching fellows (TFs) are also very helpful and are definitely less intimidating to go to than professors. TF office hours are an extremely low-stress way to really learn all the new material hurled at you in a typical life science class. **We cannot stress enough how useful TF office hours are. Go. Go every week.** Plus, talking to teaching fellows is a great way to learn more about research opportunities on campus.

**Other Students**
Study groups are a sometimes overlooked, but incredibly valuable, resource in all science courses. While professors will expect you to write-up your problem sets independently, most allow/encourage students to get together to discuss ideas on problems, strategies, do practice problems and study for exams. In courses such as physics and math, these are critical to passing the course, but helpful in most other courses as well. Get to know the students sitting around you in your classes—most likely, they will be the same students sitting next to you for the next three years as well.

§1.4 Job Opportunities

There are a lot of job opportunities on campus, many of which are organized through the Student Employment Office and the Office of Career Services. Furthermore, you can get paid for doing research—which can be your only option if you need to cover for financial aid and do research, as juggling an additional job commitment could be extremely stressful.

**Student Employment Office**

[www.seo.harvard.edu](http://www.seo.harvard.edu)

(617) 495-2585

Byerly Hall, 8 Garden Street

The SEO provides students with numerous research and job opportunities. Whether it be through work-study programs or research programs, the SEO is definitely the place to go if you’re looking for a job on campus. If you’re interested in research, the SEO provides many different types of awards to fund projects both on and off campus.

**Office of Career Services**

[www.ocs.fas.harvard.edu](http://www.ocs.fas.harvard.edu)

(615) 495-2595

54 Dunster Street

The Office of Career Services helps students in making academic and career decisions. They are very good at coaching students on interview skills, resume-writing skills, etc.

**Useful ListServs**

Signing up for weekly or daily ListServs are an incredibly convenient method of learning the latest science-related news and opportunities. Here are a few:
§2 Courses in Chemistry and Related Fields

§2.1 Choosing courses

There is a wide range of courses that can be taken by incoming freshman interested in studying chemistry and the related sciences. As the course offerings and professors have been changing frequently in the past few years, we encourage you to speak with multiple people about your selection: concentration advisors, your freshman proctor, professors, teaching fellows—and definitely the older members of the chemistry club. They are all expecting questions from freshmen regarding their specific preparation and interests and would be more than happy to advise you.

Shopping Period

Shopping period is a wonderful, uniquely Harvard way to sample a range of classes and put together your schedule. It is not unusual to shop 1-2 courses for every concentration class and 2-3 for cores and other electives. Shopping period allows you to test every aspect of your schedule from attempting to run through crowds of tourist by Harvard Hall to Northwest Labs in under 7 minutes (classes start 7 minutes after the hour to allow you passing time) to the teaching style and enthusiasm of the professor. Collect syllabi from all the courses that you shop and try to think about your semester holistically. Having a week with three papers due and two midterms or five problem sets due every Friday might not be the best schedule/would require considerable advance planning. Side note: a semester with five problem sets a week is probably not a good idea, even for the truly insane.

Even after your study card is submitted, you can switch courses with no penalty on your transcript for up to 5 weeks. This should be seen as a last resort; you will be responsible for making up the missed work/material in the course you are joining, and some professors don't allow students into their course late under any circumstance.

Class Format

Most chemistry/science courses are taught in the mornings and the intro courses tend to be a similar large lecture format. Passing 9 AM classes after 4 hours of sleep the night before is a rite of passage for chemistry
concentrators. For the truly ambitious, Annenberg offers a rather pleasant breakfast community at 8:45. Despite the large lecture format however, many courses offer opportunities for small group learning and interaction with the professors. Almost all of the science classes have sections, a 1 to 1½ hour small group meeting with a teaching fellow. Most sections will review the material from the previous week and do sample problems similar to the ones on the homework.

Freshman seminars can be a great way to know a professor; these courses are pass/fail and the professor will be really enthusiastic about the material that you are covering and getting to know the students in the class. Almost every department offers at least one freshman seminar, and there are many that are related to chemistry and other sciences.

Classes in Other Departments
Don’t be shy about looking for courses from a range of departments. At least some of the courses from the physics, biology, earth and planetary sciences, math, applied math, engineering and computer science departments will count for concentration requirements in chemistry. Use your freshmen year to explore your interests and build a foundation for your later studies—regardless of which level courses you take freshmen year, you will have plenty of time and the preparation for advanced classes.

§2.2 Chemistry and Chemical Biology

Life Sciences 1a
As part of Harvard’s initiative to draw incoming students to the sciences and to highlight the importance of interdisciplinary scientific study, Life Sciences 1a and 1b were created during the 2005-2006 academic year. Both LS 1a and 1b are designed as introductory science courses primarily for freshman interested in the biological sciences.

LS1a is an integrative biology and chemistry course, fulfilling the Science of Living Systems general education requirement, a pre-med requirement, as well as acting as a foundation course for many biology and chemistry concentrations. The course is taught by professors Richard Losick, Dan Kahne, and Rob Lue; Professor Kahne covered the majority of the chemistry concepts while Professors Losick and Lue split the biological concepts. LS1a is set apart from other courses in that the concepts taught in class are always seen through the scope of specific and real-life examples. A substantial chunk of the course is focused on studying the mechanisms of the HIV virus.
LS1a is one of the largest courses offered at Harvard, filling up a gigantic Science Center auditorium lecture hall every year. As a result, it can be slightly difficult to form a close relationship with the professors of the course. Nevertheless, if you pay a visit to the professors’ office hours, they will make an effort to get to know you. The course TFS are also very helpful, and the Sunday night Q&A pset sessions are life savers.

**Life Sciences 1b**

Life Sciences 1b serves as an introduction to genetics and genomics. It is offered during the spring term, and it is often taken by freshmen following Life Sciences 1a offered in the fall. However, it’s not uncommon for some students to take the course during the spring of their sophomore year or even later. The course’s main focus is to provide students with a solid understanding of the role of genetics and genomics in the evolution of life as well as teaching new ways of understanding and treating many diseases from the organismic to the population level. The course itself has been evolving (pun intended) over the past few years as the teaching staff not only adds on new developments happening in the field but also makes adjustments to enhance students’ experience. The class assumes little background in chemistry and a high school preparation in biology is more than enough, especially if you already took LS1a.

**Physical Sciences 1**

PS1 is an introduction to chemistry, starting with Lewis structures and then cruising through intermolecular interactions, thermochemistry, equilibrium, acids and bases, electrochemistry, and kinetics. The pset and test questions usually try to have a fun spin on them, touching on topics like biology and energy demands. It is very much a general chemistry course and is not at all considered to be demanding relative to other physical science course requirements. That being said, you will definitely want to keep up with the material, making sure you understand each topic before the class moves onto the next one. PS1 is similar to PS11, and you’ll probably wonder which one to take. They cover similar material, but PS11 is more applied—so expect more word problems—and is taught by Gregg Tucci (every Chemistry concentrator’s best friend).

**Chemistry 17, 27: Organic Chemistry**

-or-

**Chemistry 20, 30: Organic Chemistry**

Harvard offers two introductory organic chemistry sequences: Chem 17/27 (offered fall/spring, respectively) and Chem 20/30 (offered spring/fall, respectively). The Chem 17/27 series is designed for students interested in the life sciences while Chem 20/30 is geared towards
students studying chemistry and physical sciences. Except for Chem 17, each course is accompanied by 5-hour labs that occur biweekly in Chem 20 and 30 and weekly in Chem 27. While Chem 17 and 20 cannot both be taken for credit, you can take both Chem 27 and Chem 30, as 27 is more biochemistry than organic chemistry and is unique relative to Chem 17, 20, and 30.

In terms of course material, Chem 17 provides an introduction to the reactions and mechanisms of organic chemistry while 27 follows with the biological applications. Chem 20/30 focuses only on organic chemistry, its principles and application to synthesis. 20/30 covers the same topics as 17 but in considerably more depth, as well as covering a significant amount of advanced material. In addition to learning reaction mechanisms, Chem 20/30 students develop the tools and strategies required for chemical synthesis, which is essential in advanced organic courses and organic chemistry research.

Both sequences are intense, rigorous and very rewarding introductions to organic chemistry. Learning organic chemistry requires a substantial commitment of time outside of classes and consistent attention to the course material throughout the semester. Chem 30 in particular has earned a notorious reputation for its difficulty and its unflagging ability to put dark circles under the eyes of its students. Practice, practice, and more practice is key to doing well in organic chemistry. As most students will attest to, “orgo” is not a subject that can be learned by cramming the night before a test regardless of the amount of Red Bull consumed.

But have no fear! As long as you put in the effort and time, these classes will be highly rewarding, and you will have a lot of fun! To help you master the course material, the course staff supplies many resources – plentiful office hours, extra reviews before exams, a plethora of practice problems – and your peers will provide you with lots of moral support. You will be astonished by how much you have learned by the end of each class.

Are you looking for a (relatively) painless way to fulfill your medical school orgo requirement? Take Chem 17/27. Are you a thrill-seeker or a chemistry lover seeking a class to slake your unquenchable thirst for all things pericyclic and chiral? Chem 20/30 is right for you.

§2.3 Biology

*Molecular and Cellular Biology 60*
Many of the biology departments have significantly modified their introductory courses the past few years to better present the interdisciplinary nature of intermediate material. MCB 60, now in its second year, combines and replaces MCB 52 and 54 (which your upperclassman friends may have taken) and is the gateway course primarily for the MCB and CPB concentrations, the most chemistry-heavy biology concentrations. Many chemistry concentrators will also take it, to fulfill a biology requirement for the department or for medical school. MCB 60 is an integrated introduction to molecular, cellular, and developmental biology in the context of biomedicine and scientific discovery. In contrast to most introductory course lab requirements, MCB 60’s weekly 4-hour lab component gives the students investigational freedom, more accurately simulating a real research experience. After MCB 60, students have four intermediate courses to choose from, ranging from biochemistry to cellular biology. However, it is not necessary to take MCB 60 before taking some of the intermediate courses. For more information, http://lifesciences.fas.harvard.edu/mcb-course-information

§2.4 Physics and Physical Chemistry

Chemistry 40
Chemistry 40 is a great class to develop a strong understanding of inorganic chemistry utilizing the tool of molecular orbital diagrams. In past years, students learned about symmetry and group theory, coordination chemistry, organometallic chemistry, materials synthesis, and bioinorganic processes. You must have taken Organic Chemistry (17/27 or 20/30) to take Chem 40. This course is usually for sophomores in spring semester, although a few freshmen and upperclassmen take the course. In previous years, this class’s difficulty is on par with Chemistry 30 and for some even more difficult than 30. However, in this past year, under the direction of a new professor, Chem 40 has been less difficult than previously described. Spring 2015, for example, there were fewer PSETs, which required only information presented during lecture to complete. The course was manageable and attendance at office hours was not absolutely required to do well on the PSETs as was indicated from students who took Chem 40 before Spring 2015. Despite the structural changes, you will come out of this class with a new outlook of bonding in molecules, having developed a strong understanding of how molecular symmetry is related to electronic structure and how the latter can explain physical properties of molecules. Study hard in this class, and you should find the final to be a rewarding experience in applying all that you have learned.
Chemistry 60
Chemistry 60 is a one semester course on thermodynamics (remember your friends “entropy” and “enthalpy”? ). This course has been changing in recent years and will include more applications of thermodynamics to current research and problems of chemical/biological interest.

This course assumes no chemistry background beyond introductory college chemistry or equivalent high school preparation however the math and physics requirements are much higher than those in the other introductory chemistry courses. In particular, you should be taking multivariable calculus at least concurrently and have physics knowledge equal to that from AP Physics C. Chemistry concentrators are required to take two physical chemistry courses, but this particular course/placement out is not required nor a prerequisite for other physical chemistry courses in the department. For example, students interested in studying physical chemistry might enjoy the statistical mechanics approach to thermodynamics such as that presented in Chem 161.

Applied Physics 50
Applied Physics 50 is a new course that integrates information presented during lecture with group projects that test the depth of knowledge learned. This course relies heavily on group contribution to do well, as does the final project that comprises the bulk of the final grade.

Physical Sciences 2
Physical Sciences 2 and 3 make up a two-course sequence that provides life science students with a foundation in physics while fulfilling the physics pre-med requirement. In essence, PS2 and PS3 are a less rigorous sequence than the three course Physics 15 sequence, with examples and problem set questions will be drawn from the life sciences and medicine.

Physical Science 2 is offered in the fall and focuses on mechanics, elasticity, fluids and diffusion, all with a biological spin. In the past few years, the course has chiefly been taught by Logan McCarty, who provides clear and helpful lectures. As an introductory college level physics course, this progression affords a standard college physics education and contains a fair degree of overlap with the AP Physics C mechanics curriculum. However, some of the course stresses application of physical principles to the biological and chemical sciences. If you are interested in a more rigorous physics course that will cover topics such as relativity, consider taking the Physics 15a instead. Additionally, if you would like to develop your fundamental understanding following AP Physics C, as opposed to merely finding applications, consider Physics 15a.
Note: There are many ways to satisfy the chemistry concentration physics requirement. Students may fulfill their requirements by taking PS2 and PS3, 15a and PS3, or with 15a, b and c. However, students may not take only 15a and 15b, as they need both 15b and c to fulfill all of concentration electromagnetism requirements. If you are interested in concentrating in chemistry and physics, or getting a secondary in physics, you must take the 15 sequence.

**Physical Sciences 3**
As the follow-up course to Physical Sciences 2, PS3 covers the “second half” of introductory physics: electromagnetism, circuits, waves, optics, and sound. If you took AP Physics B, some of these topics will be familiar. If you have never taken a physics class in your life, never fear! The professor, Logan McCarty, actually seems to like the newbies anyway because they learn everything the “PS3” way. You will have to use some of the content from PS2, so it’s good to take PS3 right after. There are six labs over the semester, and they are directly relevant to what you learn in class and do on homework and exams.

**Physical Sciences 10**
Physical Sciences 10 is an intense introductory chemistry class that covers some of the foundational topics in quantum chemistry in the first half, and thermodynamic in the second half. There are also lab sections every other week, alternating between wet lab work, and modeling on the computer. The class uses MATLAB quite extensively, so some coding experience is recommended although not required. Due to the broad range of topics covered in this class, it is a great way to explore and find what really interests you. Be forewarned though, the class is very demanding!

**Physical Sciences 12a and 12b**
The PS 12 series replaces what was formerly physics 11a/11b. Both the 12a and 12b courses place huge emphasis on offering course materials from an analytic, numerical and experimental perspective. What that means is that in addition to traditional numerical approaches, you will get an introduction to computing packages (i.e. MATLAB) and apply programming methodology in analyzing problems in the course. The course is primarily designed for freshmen interested in the sciences and engineering, hence the emphasis on applications rather than just a swim in theories (that’s reserved for the 15 series). It is a less painful way to fulfill the physics requirement if you are someone not concentrating in physics. You will learn a good deal of statistical approaches that could be valuable in other aspects of your career.
Physics 15a/16
Physics 15a/16 both cover mechanics as well as advanced topics such as special relativity. You should keep in mind that Physics 16 is traditionally offered only during the fall semester while Physics 15a is offered both semesters. Physics 16 is significantly more challenging and assumes strong familiarity with the topics on the AP Physics C test and math sophistication.

Physics 15a
Physics 15a is a strong introduction to mechanics and a little bit of special relativity. This class requires a working knowledge of calculus (Math 1b) and most students in the class have mathematical preparation in at least multivariable calculus (Math 21a). Depending on which professor teaches the course and which TF you have for your section, your experience in the class may vary. However, it is a decently structured class and certainly one of the more structured classes you will take as a freshman. There are 3 hours of total lectures per week, 1.5 hours of section per week, 3 hours of lab per week, 1 PSET per week, two midterms, and a final. One piece of advice is to go to physics night where you make some PSET/Physics buddies, get the opportunity to learn 1:1 from TFs, and have a cookie. PSETs usually take anywhere from 6 – 10 hours. For those that have taken AP Physics C, keeping up with reading may not be essential, but for those who have not, the pace of the class will incentivize you to do so.

Physics 15b
Physics 15b is a rigorous introduction into electricity and magnetism. Physics 15b is more challenging than Physics 15a, but is required in the 15 series. Keep in mind that this is class usually composed of students who did well in Physics 15a and many students from Physics 16. Knowledge of multivariable calculus is a must (Math 21a), but this class will review some math if you are a bit rusty. AP Physics C E&M will be helpful in terms of being familiar with the topics covered, but AP problems will seem very easy in comparison with problems presented in this course. There are 3 hours of total lectures per week, 1.5 hours of section per week, 3 hours of lab per week, 1 PSET per week, two midterms, and a final. Again, physics night is highly recommended in order to succeed in the class. In addition, keeping up with the reading is integral (no pun intended... although you will do many integrals in this class) to doing well in the class, especially for the multiple-choice portion of tests. Many PSET questions are from Morin’s E&M book and reading the book gets you more acquainted with the fundamental physical concepts. PSETs usually take 6 – 10 hours to finish, but usually closer to 10 unless you work with others. One last heads up is that the midterms
and final will be hard. As a result, being able to do each and every problem on the PSETs is absolutely necessary to doing well.

§2.5 Life Sciences 50

LS50 is a two-semester, double course that introduces sciences as an integrated whole. Along with lectures, the course includes six hours of lab each week, where students can conduct original research. Being a new and more intensive course, it is appropriate for students from a wide variety of science backgrounds looking for a challenge. The course places a lot of emphasis on important quantitative/computational skills for life sciences, covering important concepts from physics, biology, and chemistry. As it is a relatively new course, you will likely benefit from talking to students who have already taken the class.

§2.6 Student Opinions: Advice on course selections

In general, but in particular for anyone with an interest in physical chemistry, I highly recommend taking linear algebra freshman year and taking quantum chemistry junior year. That will ensure that your chemistry undergrad education doesn't progress too slowly and so that by junior fall, you'll have been exposed to all the main areas of chemistry; you then have three semesters to specialize in the area you find most interesting.

- David Jaramillo ‘15

Well, I hated chemistry my freshman year. I didn't find the intro courses particularly satisfying. It wasn't until Chem 30 that I really realized I loved chemistry. I think part of it was I was in denial about liking the subject. I had told my high school teacher that I would have rather jumped off a cliff than pursue a career remotely related to chemistry. And well, here I am. Sophomore and Junior years, chemistry classes were definitely more challenging, but also immensely more rewarding.

- Grace Wang, Chemistry ‘06

You could say that I'm a late bloomer when it comes to concentrating in Chemistry. When I started I was hard set on concentrating in a Bio and doing premed. I realized after my freshman spring that this was not what I really wanted to do. However, during the course of those first two semesters I took the basic requirements that would also count for Chemistry (ie, ls1a, math 21a, ps11, ls1b). Sophomore year I decided I'd take Chem 20 although most Chemistry concentrators I knew had already done it Freshman year, however, Gregg reassured me that this
was totally fine. I can say now that this was probably one of the best decisions I made at Harvard. So, if you think you’re too late to do chemistry or that you’d have to build up a foundation in order to take classes like Chem 20 later than freshman year, don’t be afraid to do that at all.

- Christopher Johnny

I really enjoyed the course work after freshman year! I felt much more prepared for the courses I took and had meet a good group of students to work on problems sets with, developed effective study habits etc. The courses after freshman year were much smaller and more personalized. Second semester sophomore year I took two chemistry/related courses with under 10 people and one with under 30. I got to know my professors much better in these courses and found they were much more relaxed and oriented towards discussion vs. taking notes in a large science center classroom.

- Julia Mundy, Chemistry and Physics ‘06

§3 Performing Research

We are including this section since most students try research at some point during their time at Harvard—either during the summer or over the school year. However, it is certainly not expected that you start research your freshman year. There is a non-credit sophomore tutorial offered in the chemistry department that introduces you to the laboratories on campus; many students find this an excellent time in their coursework and preparation to start doing research on campus.

So you are thinking about research...
Your physical science education won’t be complete without at least some research experience. There will be plenty of resources to help you decide what research topic and what lab to join—if you choose to do so. For starters, we recommend you get an idea of the type of research that is currently happening by visiting the department websites and checking out their respective research sections.

§3.1 FAQs

“I’ve never done research before. Can I still start now? What should I do?”
No need to worry, not everyone published papers and discovered enzymes before entering Harvard. (In fact, probably very few people did). Each university and even each department uses different lab equipment
and procedures, so no matter how much or how little lab experience you have before, you're always going to learn new techniques. Professors are very much aware of this, and it is even expected that they will have to train you. Often, especially when you first start, the most basic skills you'll need is the ability to pour, press buttons, read, and most importantly—**follow directions**. By the time you need more knowledge, you'll probably have the required experience anyhow.

“I'm pre-med. I've often heard that research is good for medical school applications. Should I focus on medical research? Also, research isn't really my thing. What do I do?”

As for applying to medical schools, just as it was applying to college, there is no magical formula. Many people accepted to medical schools have participated in research, and there is also a significant number of people who have never held a test tube outside of their pre-med lab classes. If you want to go to medical school and become a doctor, the most important skills to have are those involved with being a good doctor, and that doesn't necessarily mean having done research. Especially if research isn’t your thing, consider other activities that you may enjoy, such as volunteering, singing in choirs, athletics, acting, anything. Do what you like, and show your personality, medical schools will probably appreciate that (not to mention, it will make you stand out).

If you really like research though, pursue it. Any type of research would be fine as long as you enjoy it. Again, medical schools don’t really care specifically what you have done and in what area. They are just looking to see that you are doing something, and that you have a passion for what you are doing.

“OK, I've decided that I want to do research. When should I start?”

There’s no definite answer to this question. Some would answer that you should start as early as possible so that you can learn many techniques and gain needed skills. Also, this would give you an opportunity to see whether concentrating in science and doing research is your thing. If you were thinking about concentrating in the sciences or graduate school and you discover that you would much rather not, then you still have time to decide on doing something else. (Many change their concentrations several times before graduating.)

However, it is also advisable to wait until at least your second semester of freshman year, allowing you to adjust to college during the first semester. It is completely reasonable to wait until later, even until your junior. By then, you will have a stronger background in the sciences, allowing you to have a deeper understanding of what you are doing in the lab. You will also have taken enough introductory science classes to
gain a sense of what specific area of research you would like, making the process much easier and more efficient.

“I've decided that I want to do research. How do I join a research group?”
There are numerous ways to approach joining a research group. There are three general themes: 1) know the type of work the group does, 2) consult with your concentration adviser, and 3) take your time, don’t rush this, it is very important.

One way to go about it is the following. Make sure you have perused the department research site. After developing a list for groups you would like to work with, it is recommended you meet with your advisor and discuss your reasons for selecting those groups. After narrowing down the list, and having a good idea of the type of work that each group does, you can simply email the Professors with a brief introduction, stating that you are interested in research and that you would like to know more about his or her work. At the end of the meeting, ask whether it would be possible for you to join, and mention that you are still considering other labs. Lastly, take your time to think about it.

“I've got my own research idea. What can I do?”
Harvard specifically provides funding for students wanting to do research through the Harvard College Research Program. Detailed information can be found on the SEO website. This is an especially wonderful program to keep in mind during your upperclassman years. To apply for the funding, you would need to have developed a detailed research proposal to be reviewed by the committee, and thus this option is generally more applicable after your introductory science courses. It is generally for students who have a deep understanding of their research interests and are working under the guidance of a professor. If your idea is well developed and thorough, the committee will be very willing to provide students with funding.

§3.2 Student Opinion: Getting into a Research Group
I would first not rush to join a group too soon—many require 10-20 hours a week which can be hard to balance with the number of course-based labs/sections in the intro classes. I did research during each of my summers but only worked term-time during my junior and senior years. Summer is a wonderful time to explore your interests without other coursework or obligations! In addition, many professors will allow you to observe their weekly group meetings (as I did during my sophomore year). This is also a great way to learn more about the specific graduate
student projects and get a feeling for the atmosphere in the group without/before making a formal commitment. When you are ready, my advice is to be flexible and persistent. Don’t get discouraged if a particular professor does not have space in their lab or is slow to respond to email (in this case, email multiple times and cc the group administrator). Dr. Tucci can also help alert the professor to your interest as well as make suggestions on appropriate labs to look at. I would also talk to as many undergrads and grad students as you can about the lab—ask about how many hours the professor asks for, useful coursework preparation, the general atmosphere, what exciting projects are currently going on etc. I’ve had an interview in which the professor specifically asked who in his lab I had spoken to in an effort to gage my interest!

- Julia Mundy, Chemistry and Physics ‘06

§3.3 Summer Research Opportunities

Summer is also a great time to get involved in research as you don’t have that crazy school schedule. There are many great sources for summer research.

The first is the previously mentioned Harvard College Research Program (HCRP), which also provides grants for the summer, with similar requirements as those during the school year. A similar but much more competitive program is the Herchel Smith Fellowship. This program aims to attract undergraduates who want to pursue a Ph.D. in the natural/physical sciences and/or mathematics.

Another great option is the Harvard College Program for Research in Science and Engineering (PRISE). PRISE is a summer program that offers its fellows free housing and food over 10 weeks during the summer. Fellows are Harvard undergrads who are planning to do scientific research with a Harvard affiliated PI in the Boston/Cambridge area over the summer. PRISE is a great opportunity to live in a residential community of undergraduate scientists, meet lots of great people and participate in many scientific (including distinguished speaker seminars, workshops on graduate school, talks on alternative careers in science) and non-scientific (such as a carnival, free tickets to plays, concerts, and other events, discounted tickets to Six Flags) events. For more information, please visit: http://www.priselink.harvard.edu/

There is an overwhelming amount of wonderful opportunities that you can find out more about by going to the Office of Undergraduate Research and Fellowships website, http://uraf.harvard.edu/home
§4 Final Remarks

§4.1 Why we chose to study chemistry (and still love it)

What first attracted me to chemistry were the applications to every aspect of life. Moreover, the faculty both past and present, with Nobel laureates and faculty with great teaching abilities, provided another compelling reason. And, the versatility of the degree keeps doors open, including medicine, engineering, pharmaceuticals, consulting, etc.

- Mitchel Cole ’16

I started studying chemistry simply because I wanted to understand the world around me. My chemistry education has certainly given me a new perspective on the underlying interactions that govern the physical realities that surround me every day. While this increased understanding may be rewarding enough to continue with chemistry, what really kept me in the field was the atmosphere of the department. The faculty are incredibly knowledgeable leaders of their field, but they are still incredibly approachable. The department is also small enough that I got to know most of the other concentrators well. Being in such a supportive community that is driven by the pursuit of science is all I could ask for.

- Ted McKlveen ’15

I chose chemistry because it combines rigorous, analytical thinking with the necessity to be creative in one’s approach to problem-solving. That and chemistry concentrators are a phenomenal group of hard-working, fun people.

- Andy Gonzalez ’15

I initially came in my freshman year thinking I would concentrate in Biomedical Engineering with a secondary in Chemistry. I always thought Chemistry was interesting, but after Chem 17/27, I was IN LOVE with organic chemistry! I loved learning about the types of interactions occurring in the body, and I wanted to apply this to medicine. I am now declaring a joint concentration between Chemistry and Biomedical Engineering. The Chemistry department has great professors, staff, graduate students and undergrads who LOVE what they do in addition to the amazing learning environment and fascinating research areas this department has to offer.

- Maria Brouard ’18

When I came in as a freshman I was set on concentrating in Molecular and Cellular Biology, but when I took Ps11 and spoke with Jim Anderson
About my interests he suggested that I think about Concentrating in Chemistry. After taking Chem 20 in my Sophomore Spring I knew that the Chemistry concentration truly fit my desire to study medicine at a molecular level.

- Christopher Johnny ‘18

§4.2 Final Words of Wisdom

Let me approach this from a more practical standpoint. For many freshmen, you will hear peers and advisors encouraging you to concentrate in what interests you and what sparks an academic passion. I agree to the extent that you want to at least enjoy what you are learning. To be honest, a couple of classes in a concentration is not and should not be representative of your experience in that entire concentration. There will be fantastic and meh classes in every concentration. If you at least know you want to concentrate in the sciences, choose Chemistry and Physics. Four required chemistry and four required physics courses. Almost all science courses can count towards your degree. In addition, having a science concentration simply opens more doors for graduate school (Chem grad, Physics grad, Med school) as well as employers who seek out candidates with strong quantitative backgrounds.

- Yue Ren ‘16

One, follow your interests, and never take a course simply because it is easy to do well in. By far, my favorite courses have actually been my toughest courses; for example, I’ve never felt more fulfilled after finishing a course than when I completed Chem 20/Chem 30. Two, take full advantage of your resources—attend as many OHs as possible, and try to get to know the Professors as best as you can.

- David Jaramillo ‘15

There are a million different things to do at Harvard, and a million different ways to spend your time. I have found my most meaningful, educational and enjoyable experiences have come when I have invested a lot of time in one activity. Don’t try and do it all, because you can’t. Instead, find something you love and do it the best you can. Also, remember to take courses that you are actually interested in, rather than courses that are easy. You generally won’t mind the time you spend on a course you are really interested in, and will loathe every minute you spend on a boring, but ‘easy’ course.

- Ted McKlveen ‘15
The most important lessons I've learned as a result of trying to balance school and extracurriculars are (1) things take a long time to do them right, (2) active learning/participating helps me get a lot more out of what I do, and (3) less is more.

- Jeremy Chang, Chemistry and Physics ’06

1. Don’t be afraid to ask questions
2. If a professor doesn’t get back to you, don’t take it as a rejection. Just go back and ask him or her again.
3. Look up the harvardchemclub list online to speak with other undergraduates who are in the research group that you’re interested in; they’ll be valuable sources of information.

- Nan Lin, Chemistry ’07

§4.3 Acknowledgements

We are gratefully indebted to the 2006-2007 Harvard Chemistry Club, as we used their version as a template and have kept a lot of their material, as it has turned out to be timeless. We would also like to thank Dr. Gregg Tucci for helping us put this guide together, but more importantly, for his expertise, unwavering commitment, and genuine dedication to the Chemistry Club, and to each and every chemistry concentrator.
§5 Map of Science Buildings Area

Dept. of Chemistry and Chemical Biology—Mallinckrodt Laboratories
Dept. of Physics—Jefferson Laboratories
Dept. of Molecular and Cellular Biology—Fairchild Laboratories
Dept. of Integrative Biology (Organismic and Evolutionary Biology)—Fairchild Laboratories

- Chinese food truck
- Chem club socials
- Biology buildings
- Physics buildings
- Chemistry buildings
- Most intro science lectures
- Freshman dining hall
- Loker Commons below
- Cabot science library
- Dr. Tucci’s office

Most intro science lectures

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