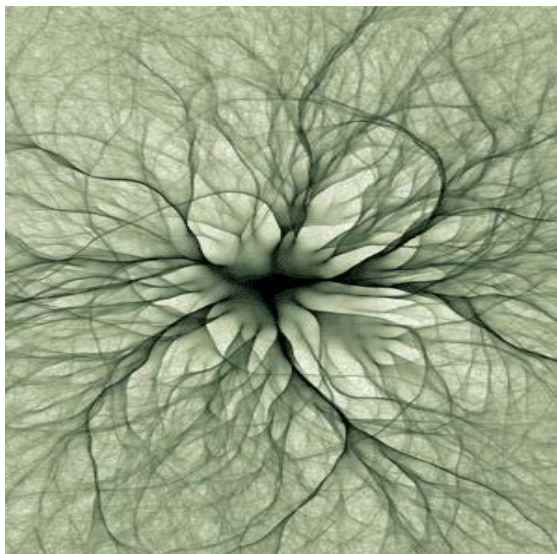
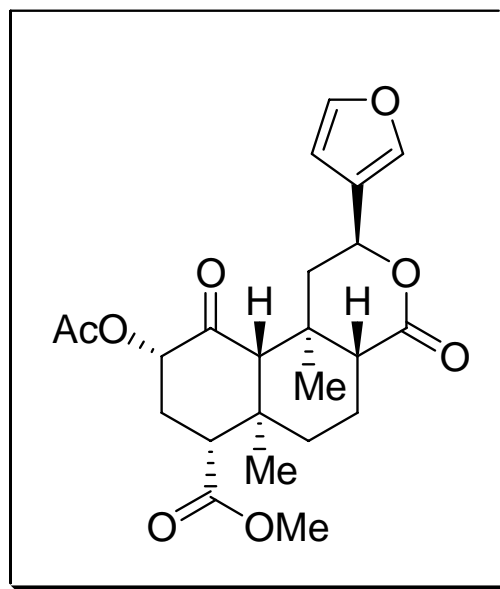


The Freshmen Guide to Chemistry and Related Fields



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Presented by the
Harvard Chemistry Club
2007-2008

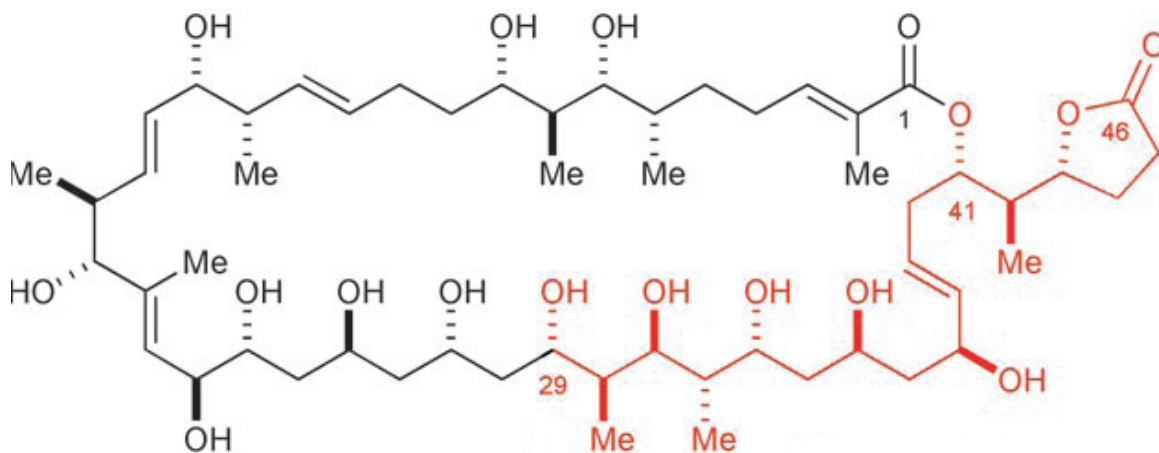


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Dear Possible Science Concentrator,

We hope you're enjoying your time discovering where all the buildings are, trying to find the shortest paths to each destination in seven minutes¹, exploring Harvard Square, etc. Of course there's schoolwork to think about, which is why we've put together this handy guide for you. It includes information ranging from who to talk to about a potential concentration², student perspectives on classes in the biology, chemistry, and physics departments, student groups you may want to consider joining³, and information about research (for later consideration). We intended this guide as a handy reference, to 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 that we learned when we were freshmen. We'll even let you in on some of the lingo used here and some of the Harvard quirks—hence the footnotes. You'll catch on in no time what WISHR, TF, and PI stand for⁴. As the year progresses, come visit us at our Harvard Chemistry Club socials and luncheons 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!

Harvard Chemistry Club

¹ 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... Everyone almost expects everyone else to be seven minutes late, so it becomes sort of a catch-22. Why seven you ask? Who knows, maybe the administration wanted good luck or something.

² 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.

³ You didn't think I wouldn't stop here and advertise for the Harvard Chemistry Club. It's us, after all, who have put this wonderful guide into your hands. Stop by for one of our amazing socials sometime. Our food is so great that we even get econ majors piggy-backing off of their chemistry concentrator roommates (seriously).

⁴ Answers may be found throughout this guide. First person with the correct answers and the page numbers of where the answers are found on will get a special prize at the next Chemistry Club social (seriously, the social coordinators know about this).

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 at Harvard, after an intense application process and months of waiting, you may have realized that sometimes Harvard isn’t all that its cracked up to be. 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. But 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. Undoubtedly the best resource in trying to determine what classes are best for you and thinking about concentration choices are the concentration advisors.

Science Resources

During the past academic year there have been many changes to Harvard’s undergraduate science curriculum. Several new concentrations were developed and several old ones (such as Biochemical Sciences and Biology) are no longer open to incoming freshmen. Information for these “old” concentrations are not listed here. 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.

Concentration Advisors

Chemical and Physical Biology

Prof. Daniel Kahne (Co-Head Tutor)

kahne@chemistry.harvard.edu

(617) 496-0208

OR

Prof. Erin O’Shea (Co-Head Tutor)

Erin_oshea@harvard.edu

(617) 495-4328

See also: www.lifescience.fas.harvard.edu/concentrations/

Chemical and Physical Biology (CPB) is a concentration created during the Spring, 2005 semester. CPB was designed to meet the interests of students who were interested in quantitative physical sciences but who wanted to apply such skills to the systematic study of biology. Advising in CPB began in Summer 2006 and every concentrator (and those interested in concentrating) will be assigned a Concentrator Advisor, all of whom have a Ph.D. and/or M.D. Please see the above website for a more comprehensive description of CPB and the other life science concentrations

Chemistry: Dr. Gregg Tucci
tucci@fas.harvard.edu
(617) 496-4668
Science Center 114 (across from the elevators)
See also: www.chem.harvard.edu

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 in 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. In addition, his children are adorable.

Chemistry and Physics:

Dr. David Morin
morin@physics.harvard.edu
(617) 495-3257
Lyman 233
See also: www.physics.harvard.edu, www.chem.harvard.edu

In addition to teaching Physics 15a, Dr. Morin is the Assistant Head Tutor for Chemistry and Physics. His office is in Lyman Hall, which is behind the Science Center as you walk towards the Law School. Dr. Morin and Professor Georgi, who also serves as the

Leverett House Master, are both very approachable and are expecting questions from freshman regarding their physics course selections.

Molecular and Cellular Biology

Prof. Richard M. Losick (Head Tutor)

losick@mcb.harvard.edu

OR

Dr. Tom Torrello

torrello@fas.harvard.edu

7 Divinity Ave., Fairchild 195 (on the left as you walk down Div. Ave.)

See also: www.lifescience.fas.harvard.edu/concentrations/, www.mcb.harvard.edu

Molecular and Cellular Biology (MCB) is a fairly new concentration, one that was previously classified under Biochemical Sciences. MCB is intended for the student who is interested in pursuing careers in cellular biology research or medicine and for the individual who wishes to combine interests in chemistry, physics, and math through the study of cellular processes. Like CPB, MCB has a tutorial program that is run through the Board of Tutors in Biochemical Sciences. For more information, contact Tom Torrello at the above phone number to schedule a meeting.

Organismic and Evolutionary Biology

Prof. David Haig, Head Tutor

dhaig@oeb.harvard.edu

Room 42B, Botanical Museum, 26 Oxford St.

(Head past the Science Center and Annenberg, get onto Oxford St. and keep walking straight. It will be on the right)

OEB is an interdisciplinary concentration preparing 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, OEB requires its students to take a significant amount of biology. In addition, OEB 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. For more information, contact Prof. David Haig, Head Tutor for OEB.

Physics:

Prof. Howard Georgi

georgi@physics.harvard.edu

(617) 496-8293

Jefferson 456 (behind the Science Center)

Prof. Georgi serves as the advisor for physics concentrators and is an incredibly interesting person to get to know in general. He and Dr. Morin run a physics table in Leverett on Wednesday nights, definitely a plus if you ever plan on taking physics and can't figure out which frame of reference to work in. Prof. Georgi is a great teacher and advisor and physics concentrators are lucky to count him as their concentration head.

Alright, so you've gotten a chance to talk to people who can help you decide on classes and maybe have even started thinking about possible concentrations. So now what should you do? Well, like every other Harvard student you will probably be checking your Facebook account to see if any people have updated their profiles in the last 10 minutes.

But seriously after that, what? 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, I'll just briefly talk about a few student academic groups (though if you're interested, the Mission Hill After-School Program is basically the hottest thing since boba tea).

Student Academic Groups

Harvard Chemistry Club

Alright I'll be honest. We're basically awesome. The Chemistry Club is a well-known organization on campus with tons of great people in the club. We sponsor guest lectures, a research symposium for concentrators in chemistry and related fields in the spring, help sponsor the very successful Harvard Undergraduate Research Symposium (HURS), have socials with chemistry clubs from other local schools, have INCREDIBLE socials just amongst us, and, most importantly, **we have the best food on campus**. To find out more about us, visit

<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 to organize socials, physics presentations by undergraduates, organize a buddy system to help incoming students interested in physics, among a variety of other activities. To learn more: <http://hcs.harvard.edu/~twiki/bin/view.cgi/SPS>.

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://hcs.harvard.edu/~wishr/>

Harvard University Biological Sciences Society (HUBSS)

The Harvard Undergraduate Biological Sciences Society (HUBSS) exists to serve the biology 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://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; including concentrations in: neurobiology, psychology, philosophy, computer science, history of science, biological anthropology, and linguistics; a forum to talk more about their academic interests, as well as learn more about MBB in different fields. They meet weekly in the Eliot Small Dining Room. To learn more about HSMBB, please visit: <http://hcs.harvard.edu/~hsmbb/>

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 ABSOLUTELY 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.

Peer Concentration Counselors

The Peer Concentration Counselors Program is a program that allows freshmen to get in touch with upperclassmen in their field of study to learn more about their experiences and classes. While the counselors aren't tutors, they can provide valuable insight into the structure of various classes and in general their experiences in their concentration. To learn more and for a full list and contact information for the counselors go to:

http://www.college.harvard.edu/academics/advising/peer_counselors/index.html

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

Make an earnest effort to get to know professors. I know that it can be difficult and intimidating, but it is only by talking to professors one-on-one do you get a better feeling for their own passions and what motivates them in studying the topics they do. Plus, you get a sense of how a respected scientist thinks about the scientific problems he/she faces every day; a perspective that you can never get from just doing problem sets and reading textbooks.

-Arun Thottumkara, Chemistry '08

Teaching fellows (TFs) are also very helpful and are definitely less intimidating to go to than professors. 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.

Job Opportunities

You know how on the *Wonder Years* the grumpy dad character was always obsessed with getting Fred Savage's character a job? And Fred had to work in places he hated all while pining for Winnie Cooper? Well at Harvard you don't have to work in places you hate. 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.

Student Employment Office:

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 research projects on campus. The Harvard College Research Program (which is described in detail later) is run through the SEO.

Office of Career Services: 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. Moreover, if you are looking for fellowship opportunities, OCS not only offers advising on fellowships but also a fairly comprehensive library that can give you the one-up in the fellowship process.

Courses in Chemistry and Related Fields

Choosing courses

There is a wide range of courses that can be taken by incoming freshman interested in studying chemistry and the related sciences. Especially as the courses 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, peer concentration counselors, your freshman proctor, professors, teaching fellows, etc. 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 time 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 3+ for cores and other electives. Shopping period allows you to test every aspect of your schedule from attempting to run through construction from Harvard Hall to Maxwell Dworkin 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 never a good idea, even for the truly insane. Running full speed at a brick wall and then repeatedly banging your head against it will produce the same effect in much less time.

Harvard also offers a slightly extended “shopping period.” Even after your study card is submitted, you can switch courses with no penalty on your transcript for up to 5 weeks. With the exception of a few courses (ie Physics 16 to 15a or within some math levels), 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, some professors don't allow students into their course late under any circumstance and the registrar will start to add an increasing fee.

Class Format

Realistically, 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 1 ½ 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.

The chemistry department currently offers two freshmen seminars, which are amazing opportunities to get to know a professor well; professors design their own seminars and 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.

General Chemistry

Life and Physical Sciences A--new course this year

This course introduces fundamental concepts in chemistry and biology. Topics in chemistry include stoichiometry, acids and bases, aqueous solutions, gases, thermochemistry, electrons in atoms, and chemical bonding. Topics in biology include the transfer of information from DNA to RNA to protein, genetic inheritance, mitosis and meiosis, cell structure and physiology, and natural selection. Moreover, our very own Gregg Tucci, along with Tamara Brenner, will serve as the course heads for this class. This course is meant for students who have had little or no preparation in the physical and biological sciences during high school but are interested in pursuing science courses in college. Students who take this course will be able to proceed to more advanced classes in the spring semester of freshman year and during sophomore year.

Physical Sciences 1

Like the Life Sciences classes (see below), PS1 centers its course material around three central themes: 1. world energy sources, 2. global climate change, and 3. modern materials. Co-taught by two professors, PS1 will teach the fundamental concepts in chemistry, including thermodynamics, kinetics, entropy and enthalpy, and a variety of topics. PS1 is NOT, however, AP Chem, and the topics covered are covered in much more detail than AP Chemistry covers. If you are interested in pursuing studies in physical sciences (this includes Chemistry), this is probably where you want to begin, though we urge you to talk to concentration advisors and professors if you are unsure whether this class (or any other for that matter) is the one for you.

Biology/Biochemistry

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. Unlike many other introductory courses, LS 1a is unique in its approach to teaching: the entire class is structured around the problems of HIV/AIDS and understanding the disease through a focused study of cell biology, biochemistry, and chemistry.

Life Sciences 1b

Life Sciences 1b is a one semester course that serves as an introduction to genetics and genomics. It is offered both fall and spring terms. The course material centers around the function, mutation, and evolution of genes. The course has been revised over the years such that the professors now spend a good amount of time on recent topics in genetics. The class assumes little background in chemistry and a high school preparation in biology.

Freshmen Seminars

The chemistry department offers at least two freshman seminars each year—currently both during the spring semester. These courses, once again, are great opportunities to get to know a member of the faculty well and study a more advanced topic in depth. There are also similar seminars offered with the physics and biology departments in both the fall and spring. There are very few of these

specific, small seminar type courses offered in the chemistry department (or many other science departments for that matter), so don't miss your chance to take one freshman year! Plus, while it is great if you decide to take a chemistry/science freshman seminar, remember that the freshman seminar is designed to allow you to explore very different fields, so don't be afraid to take a seminar in a field completely unrelated to what you think your concentration will be.

Student Opinion: Freshman Seminar

While I enjoyed my chemistry courses, it was really my freshman seminar, Seeing by Spectroscopy with Professor Klemperer, that convinced me to concentrate in chemistry. We went on tours of a number of labs in the department-
-I was really excited by the research going on and the dynamic community beyond the classroom.

- Julia Mundy, *Chemistry and Physics '06*

Organic Chemistry

Chemistry 17, 27: Organic Chemistry

- and -

Chemistry 20, 30: Organic Chemistry

Harvard offers two introductory organic chemistry sequences: Chem 17/27 and Chem 20/30. The Chem 17, 27 sequence is designed for students interested in the life sciences while Chem 20, 30 is geared towards pure organic or physical chemistry research. Chem 17 and 20 cannot both be taken for credit, however you can take either Chem 30 following the 17/27 sequence or 27 following the 20/30 sequence. Chem 27 and Chem 30 are both accompanied by a 5 hour weekly lab. Note that if you take both 27 and 30, the lab only needs to be completed once.

Both sequences are intense, rigorous and very rewarding introductions to organic chemistry. Learning organic chemistry (and especially doing well!) requires a substantial commitment of time outside of classes and consistent attention to the course material throughout the semester. 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 purchased or your intentions. However, as long as you are prepared, these classes are nothing to be feared and are a lot of fun! The course staff provides many opportunities for office hours, extra reviews before exams, additional problems and moral support.

In choosing between the courses, a large factor is the semester that they are offered: students who take the Life Sciences 1a/1b sequence usually take 17/27 since it follows in the fall of their sophomore year. Chem 20 is offered in the spring and 30 in the fall. However, the Life Sciences and Physical Sciences courses certainly provide the background for Chem 20/30 if you are interested. In terms of course material, Chem 17 provides an intense introduction to the reactions and strategies of organic chemistry while 27 follows with the biological applications. Chem 20, 30 go through the actual topics at a slower rate, but do so in considerably more depth and develop the synthetic strategy for the advanced organic courses/organic chemistry research.

Biology/Biochemistry

Molecular and Cellular Biology 52

A great introduction to molecular genetics, this course is great for those who are concentrating in biology or just have an interest. This can be a class that you could easily fall behind in with all the transcription factors that need to be memorized (remember that eukaryotes and prokaryotes have different sets), but once you do catch up in time for the final, you'll marvel at how extraordinary molecular genetics can actually be. The class size can be intimidating, consisting of virtually all biology concentrators, a significant number of chemistry concentrators, and the non-science pre-meds, but plenty of upperclassmen who have taken it are more than willing to help. Although chemistry concentrators are not required to take this class, it is good to take for background knowledge. Much of chemistry and biology are interrelated, and you might just end up in a research group that deals with some biology. This class is usually intended for sophomores, although the content is manageable for most. However, this is likely a class that you'll end up taking with the largest number of your friends, so it's fine to just consider it for now. As a final note, watch out for those "breakout questions." Attend the first class to find out more.

Molecular and Cellular Biology 54

The other biology class taken by virtually all the biology and chemistry concentrators, this class progresses from the DNA transcription and translation taught in BS 52 to the rest of the cell. You'll once again marvel at the wonderful complexity of how the cell fits together—after memorizing the "alphabet soup" of proteins involved in the cell cycle alone (MCM2, CDC20, CDC4, p53, just to name a few). Again, most who take BS52 take this class, but the wonderful animations that the instructors introduce are well worth attending class. The "breakout questions" are also a good part of the class, but you'll likely know what they are when you do take it.

Student opinion:

Taking BS 52 and 54 has been a great choice for me. Although I'm a chemistry concentrator, I've been working in a biology lab, so having some biology knowledge was good for me. I also feel that the biology and chemistry are so interrelated that it's difficult to limit learning to just one subject. The professors were great and they had great animations that really helped me understand the biology on a molecular basis.

Physics/Physical Chemistry

Chemistry 60: Physical Chemistry

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 Physics 11 or 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.

Physics 11a/11b: Mechanics (1st semester) Electricity and Magnetism (2nd semester)

The physics 11 series is taken by a whole range of students, from those who have taken physics in high school but no AP Physics, to those who have taken AP Physics, and finally to those who have medaled in the Siemens Westinghouse Competitions. While finding a happy medium is difficult for the professor and can at times be frustrating for the students, it's a good fit for those who have some interest in physics but don't necessarily have the math background. However, a word of advise. For those who do have a decent physics background, do consider taking the Physics 15 series. The math involved in these classes are not necessarily much more difficult. However, physics is a subject that is taught best either with some calculus or without any, so at times finding the middle ground in this class is not necessary successful and often the lament of many of the students.

Physics 15a/16: Mechanics

The physics 15 series is a rigorous three-semester introduction to physics designed for concentrators in physics, chemistry and physics and astronomy. Physics 15a/16 both cover mechanics as well as advanced topics such as special relativity. Physics 16 assumes familiarity with the topics on the AP Physics C test and considerable math sophistication. Advising is provided in the courses on which would be the most appropriate match for you; in addition, both courses are offered at the same time and allow students to switch between for the first few weeks of the semester.

Student Opinions: How Courses Changed after Freshman year

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

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

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 even start to think about research until your sophomore or junior 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...

You hear about it all the time on the news. You hear your classmates talk about the complicated lab procedures they learned over the summer. You flip through your most current “Courses of Instruction” and you see *Chemistry 99r. Introduction to Research—Junior Year*. Now what is this fuss all about?

I won't bore you with Webster's definition of research, but most simply put, doing research is asking a question, thinking about it, using various sources to gain more knowledge to seek ways to answer your question, and stringing together many words so that it makes sense to others. Many students at Harvard are involved in research, whether working on their own projects or under the direction of a professor. If this is something that interests you, then you should definitely look into doing it.

But some questions you may have...

“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 (some are handmade, which is very impressive), 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. Therefore, do not worry. 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 or senior year. 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?”

For those of you who have experience applying for jobs your experience will come in handy right about now. First, you have to do your own bit of research. Look at the department websites and read the descriptions of research groups. Note the professors of those groups that interest you. You should try to locate past publications, which will help you understand the research interests of the group as well as give you something to discuss when being interviewed. In addition, you can consult the Harvard Student Employment Office (SEO) website, which lists jobs on and around campus, including positions as research assistants. Positions advertised on the SEO website are also generally paid, which makes the website a good place to start.

Next, you may have to send out cover letters and resumes to those professors that you had noted earlier. Expressing enthusiasm for the professors' research will always be helpful. For help on writing cover letters, consult the Office of Career Services (OCS), either in person or via their website. They are a great source, with counselors available daily to help you work on your resume and cover letter.

Finally, you get to play the waiting and interviewing game. Don't get discouraged if you get few responses or don't get the position you wanted on your first try. It isn't unusual to not hear back from any one of the twenty something letters you send out (and I mean twenty something), especially during freshmen year, when you haven't taken the organic chemistry or the biology classes the professors believe is necessary. Just keep trying, and eventually something will work out.⁵

⁵ In case you're still wondering, PI stands for principle investigator, sometimes used in reference to the professor in charge of the research group. You certainly don't have to Not everyone call anyone that, and it actually seems to be a bio lab thing, but just in case it does come up, now you'll know.

“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.

More things to consider...

You don’t have to just do research during the school year. In fact, you can opt to just work on research projects during the summer, and leave the school year for other activities. If you end up concentrating in the sciences, you may take a combination of biology, chemistry, physics classes all during the same semester, and if each has a four to six-hour labs—well, you do the math.

Research is not just limited to science concentrations. Each field has research going on, just maybe not in the traditional making enzymes and working with machines sense. The psychology department is often overlooked, and yet research assistants are always needed to help conduct psychology studies. And if you like the humanities, many professors or graduate students would welcome students to help in their library research. The Student Employment Office website advertises many positions under the heading “research assistant,” even the non-traditional ones for you to consider.

And for even later consideration...

Summer is also a great time to get involved in research. You don’t have that crazy school schedule. You’d otherwise sit at home and watch countless hours of mindless TV. (Or, you’d much rather not go home for the summer.) There are many great sources for summer research.

The first is the previously mentioned Harvard College Research Program, which also provides grants for the summer, with similar requirements as those during the school year.

Another is the Research Experience for Undergraduates program (REU), a summer opportunity funded by the National Science Foundation. Students must apply to different REU sites hosted by various universities, listed on the website: www.nsf.gov/home/crssprgm/reu/start.htm. Room and board is supplied, but as a result, this program is competitive, with students from around the country applying. The deadlines are during the spring, so don’t wait too long to look into these programs.

And especially geared towards freshmen and sophomores with little research experience, there is the Herschel Smith fellowship. It is also competitive, but you would be competing against Harvard students only. Additional information is provided by the Office of Career Services, with spring deadlines as well.

A new program launched in 2006 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/>

Student Opinion: Getting into a Research Group

I think the best way to get into a research group is to show an active interest in the work that the group is doing. I would advise definitely contacting professors or their secretaries and seeing whether you can attend some of their group meetings to learn more about their research. Also, talk to TFs and other graduate students and see what they think about their labs. Oftentimes not only will they give you great advice about types of classes to take and what to expect from lab, but they can also help you a lot with finding a research mentor.

-Arun Thottumkara, Chemistry ‘08

I would first not rush to join a group too soon—many require 10-15 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 seniors 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 gauge my interest!

-Julia Mundy, Chemistry and Physics '06

One of the great things about coming to a large university like Harvard is the tremendous opportunity to do research as an undergrad, not just with FAS faculty, but also at the Med School and the numerous medical institutions affiliated with Harvard (and even MIT, if you're really interested). The key is to cast a wide net. Go online, read the lab research summaries and email any professor whom you think is doing interesting work. (Just say something like, "Hi, my name is ---. I'm an undergrad at Harvard and I would like to explore the possibility of doing research at your lab.") The worst thing that can happen is that there's no open position at the lab or no response at all. But hey, email is cheap (free in fact), so there's nothing to lose.

-Yin Li, '08

Final Remarks

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

They say "chemistry is the central science" for a reason! I am particularly interested in the interface between chemistry and biology, but more from the chemical perspective. But perhaps most importantly, chemistry is like a chess game – intellectually engaging and fun. You can't get a better academic field.

-Vijay Yanamadala, Biochemical Sciences '07

I really loved the faculty and the importance that the department placed undergraduate education. They really made the subject even more enjoyable! (I switched from neurobiology, where I felt that undergraduates are not put very high priority-wise.) Find something that you are passionate about and don't be afraid to stray from your "original plans." I know that was something I was struggling with, since I thought I had wanted to be neurobiology ALL my life, but I'm SO glad I made the switch and haven't regretted it since!

-Grace Wang, Chemistry '06

Being interested in all kinds of science before coming to Harvard, I chose to take some chemistry classes out of general interest and without any real expectations. It was very challenging in the beginning, being surrounded by so many brilliant classmates and encountering material I never knew even existed. However, the dedication of the chemistry faculty to teaching and undergraduate education really stood apart from my other classes, and I was soon captivated by chemistry.

-Brian Liau, Chemistry and Physics '07

I switched from English to Chemistry after taking Chem17 sophomore year. I really enjoyed organic chemistry, and I wanted to pursue it in more depth. As far as advice for freshman choosing a concentration, I think it is important to realize you can always switch concentrations :) Don't let your plans for the future be so rigid that you don't have room to explore new and different classes, departments, fields of research, etc.

-Nicole Cobb, Chemistry '06

I was deciding between chemistry and biochem, and I went to meet with Dr. Tucci to discuss the chem program. He was extremely helpful in laying out a tentative plan that was catered to my career plans, and I didn't feel a need to go visit the biochem department after meeting with him. I was expecting to be behind having come from a non-AP high school chem. and doing 5/7 [former intro chem. Classes] instead of orgo as a freshman. I have not found this to be the case at all.

-Andy Howe, Chemistry '08

Final Words of Wisdom:

Don't stress out too much [about concentrations]. I have wavered so much since making my decision. Ultimately, it really doesn't matter too much. For example, the difference between Biochem and Chem and Phys is all of two courses. Especially if you're deciding between this narrow range, see where you fit best. Also, be sure to take some physics and biology early on – though we all love chemistry, having a varied background really helps.

-Vijay Yanamadala, Biochemical Sciences and Chemistry '07

Don't be frustrated by a "slow start" or difficult classes. Ultimately, just find what you are passionate about and go with it. Grades are extremely important, but only to a certain point. I am by no means a flaming genius (and many have told me very explicitly that I am

not), but I got into my first choice lab and was selected for a very competitive industry internship. Hard work is the key to your success, no matter what you do. Never give up, and always be yourself!

- *Grace Wang, Chemistry '06*

Balancing extracurriculars, labwork, and classwork is always very difficult. Personally I could spend lots and lots of time in lab and have to consciously make an effort to really prohibit myself from spending too much time there. It is important to realize that while research is very important and fun, classwork will really provide a large part of the basis for your ability to think and reason as a scientist. Figure out what is best for you in terms of time spent in lab and stick with that. I always find it helpful to plan out exactly what I want to do in lab on a certain day and that way I am not spending excess time there when I could be studying for a class.

-*Arun Thottumkara, Chemistry '08*

As a chemistry concentrator, one of the most fulfilling experiences of my undergraduate career has been working in a lab. The awesome thing about studying chemistry at Harvard is that you can learn about reactions and techniques in class and then head to the lab to work with some amazingly talented people and actually perform the reactions firsthand. Chemistry became much more real to me once I was able to use what I had studied for practical purposes in the course of my research. Finding a lab that's a good fit takes some persistence, but it's definitely worth the effort.

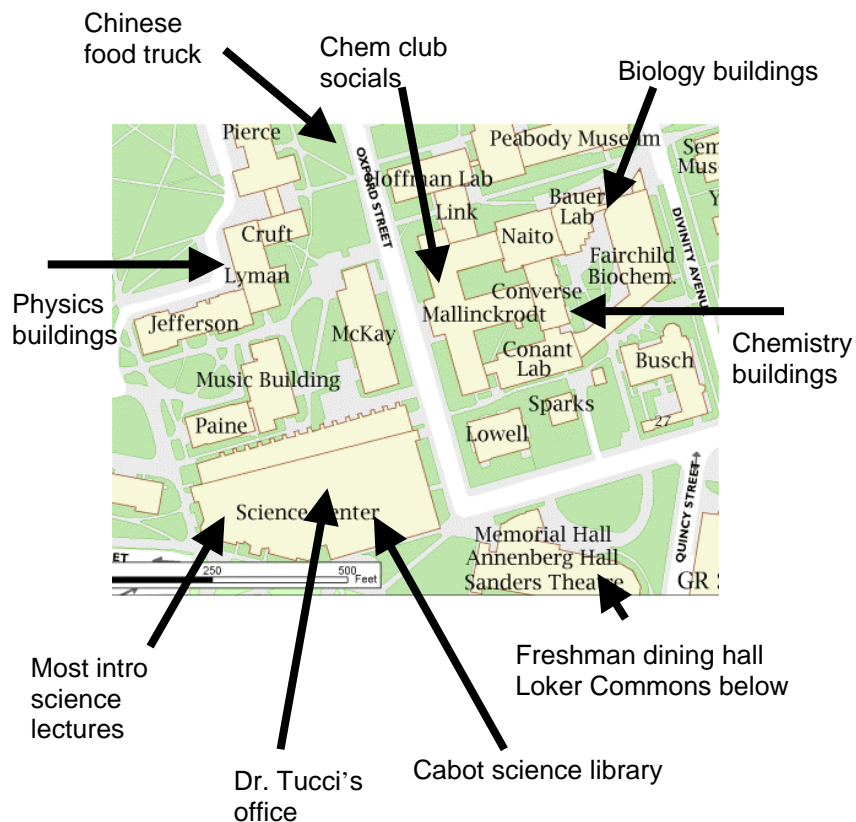
-*Chelsea Gordon, Chemistry '09*

Taking science classes can be a little overwhelming at first. The problem sets are often much more difficult and lengthy than anything given in high school... Talking to other people, bouncing ideas off of each other, is often illuminating; struggling together in on problem sets is also an inevitable bonding experience (many of my best friends were my classmates in Chem 15: Inorganic Chemistry, which, alas, is no longer offered). For some classes, office hours are also helpful, but this is dependent on how good the professor and the TFs are. Don't be shy about sending questions to TFs and professors to clarify wording, which, in the best traditions of academia, can be labyrinthine and opaque.

-*Yin Li, '08*

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 Organismic and Evolutionary Biology—Fairchild Laboratories



Harvard Chemistry Club
<http://www.hcs.harvard.edu/chemclub/>