

# Is Graduate School in Your Future?

This chapter has been written for undergraduates who might want to consider advanced study in the sciences. It may raise more questions than it answers. Please call or see an advisor or a faculty member if you need further information or advice.

## 1 Why Go to Graduate School?

An undergraduate degree in the sciences prepares you for many good jobs: laboratory technician, national park service, US Geological survey, etc. But there are many jobs that require advanced degrees: university professor, head of an industrial research division, etc. And there are many others that are difficult to attain without an advanced degree. Many graduate students report that they returned to school because they quickly reached a ceiling in industry above which they could not climb; project managers were almost always people with M.S. or Ph.D. degrees.

Research teams in the top industry think-tanks (IBM research centers, Xerox PARC, etc.) and government labs (Argonne, Los Alamos, NASA, etc.) consist primarily of people holding masters or doctorate degrees. For better or for worse, the people who have the most flexibility in their choice of projects and methods, whether in industry or academics, are usually those with the highest degrees.

One of the goals of education is to make people aware of how little they know. An undergraduate major acquires a great deal of knowledge, but there are many (fun!) things that you do not have time to explore. The excitement of exploring the cutting edge of knowledge, and the thrill of your first research result, something *you* have discovered that no one else in the world knows, are worth savoring.

## 2 Can You Afford It?

Very few graduate students in the sciences pay tuition. Because of this, even the most expensive private schools are accessible to most students who meet admission requirements.

Some students are supported by fellowships (i.e., scholarships). These fellowships are based on scholastic aptitude rather than on need. Some are awarded in nationwide competition by government (NSF) or private foundations. Some are awarded by the individual schools.

Some students are supported by their employers and given full or part release time to complete their degree requirements. Often the student is required to return to the company for a minimum time after completion of the degree.

The majority of graduate students work their way through school on assistantships, serving as teaching or research assistants. The typical work load is 20 hours per week, and the experience can be a valuable preparation for a career.

Teaching assistants may grade papers, teach laboratory or recitation sections, or be responsible for lecturing to a small section of a course. These assistants work under more or less close supervision by a faculty member, and usually attend training sessions before their first semester as a teaching assistant.

The jobs of research assistants may be less structured. They are responsible for learning about the general orientation of their professor's research and may assist that professor by developing or maintaining software or hardware, writing reports, supervising other students, and presenting research results at meetings.

Students on assistantships have these extra duties, but they also have office space and tend to feel more at home in the department. Students with fellowships or outside support need to make extra efforts to interact with faculty members and network with fellow students.

Typical stipends for fellowships and assistantships are \$9,000-\$15,000 annually plus free tuition. Graduate students don't get rich, but they don't starve.

### **3 What Is Graduate School Like?**

Think back to the transition you made from high school to college. Your first semester may have been a time of great upheaval as you adjusted to additional freedom and additional responsibilities. Most students find college much less structured than high school, and they need greater discipline to budget their time and complete long-range projects.

Graduate students have much the same reaction as they make the transition from undergraduate life. A typical full-time course load is 9 hours. This means less time spent in class, but the demands of a graduate course are much greater than those of an undergraduate one, and students might spend three or four hours of preparation for every hour in class. Standards are higher: a "C" is often not a passing grade for a graduate student, even in an undergraduate-level course. There are fewer "checkpoints" (exams and due dates), and it is easier to yield to an urge to procrastinate.

A masters student typically completes a specified set of courses in the first year or so, and then spends time working on a research project with an individual faculty member. The completed project is written up as a thesis, and then the candidate gives a talk to a group of three or four faculty members and "defends" the work. The entire process may take two years, perhaps three. Some schools allow a written exam plus a scholarly paper to substitute for the research project.

The Ph.D. student follows a similar track, perhaps taking some required courses and a written exam. There may be a foreign language exam as well. Before research is begun, however, there is usually an oral "candidacy" exam during which the candidate presents the research idea and is questioned on the necessary background knowledge. The student then completes the thesis research, writes it up, and has an oral defense. The entire process may take five years of graduate study (three beyond the masters degree), possibly as few as three years or as many as seven years.

The matchmaking of students to thesis advisors is a rather informal process. The student needs some initiative in order to seek out an advisor with compatible ideas and working style.

The thesis writing period is a particularly unstructured one with no exam or homework deadlines to meet. Again, extra discipline is required to keep the work progressing.

## **4 Could You Succeed in Graduate School?**

If you are a science major in a top-20 department, typically get A's and B's, have a good deal of self discipline, and are MOTIVATED, then you are a competitive applicant for the best graduate schools in the country. If your department is not top-20, then in addition to the top schools, you might want to apply to some lower-ranked departments as well. If your ultimate aim is a top-ranked school, then a masters degree from a mid-range school, coupled with supportive letters from your professors, can be a stepping stone toward this goal.

## **5 How Should You Prepare for Graduate School?**

There are several things you can do (beginning in your freshman year!) that will make admission to graduate school and future success easier. Luckily, they are also good preparation for the business world, so you do not need to sacrifice any of your options.

1. Work hard in your courses, especially your major courses.
2. Take senior-level core courses in your major as early as you can. If you postpone most of them to your last semester, graduate schools will not have as much information about you.
3. Get to know a handful of faculty members well enough that they can give you advice and write knowledgeable letters about your talent, performance, and motivation. Don't try to go through school anonymously. If possible, choose teachers who are well known in their fields; their opinions mean a lot to graduate admissions committees.
4. Join a departmental honors program. Working on a project is an excellent way to get to know a faculty member, to receive individualized instruction, and to get an introduction to research.
5. Participate in other outside career-related activities. In computer science, look for organizations such as student American Chemical Society Chapters, Sigma

- Gamma Epsilon (Geology Honors), Society for the Advancement of Chicano and Native Americans in Science, etc. In the sciences learn about the professional organizations like SETAC, GSA, AGU etc.
6. Don't get over-committed, but one or two activities are worthwhile.
  7. Start learning about various graduate schools early, preferably in your junior year. Visit your undergraduate office or library to see some catalogs. Write to some schools and skim some journal publications by their faculty members.

Start working on the application process early in Fall for admission the following Fall.

- Watch for deadlines to take the GRE Exam, the ``SAT" of graduate school. Plan to take the exam in October or December.
- Explore fellowship opportunities. Contact the NSF and other agencies. Talk to your advisor and ask for pointers.
- Plan to apply early: deadlines may be in December or January, particularly if you are seeking financial aid.
- Choose as references faculty members who know your work well. Talk to them about your goals.

Some students go on to graduate school directly after completing their undergraduate degrees; others gain some work experience before returning to school. There are arguments for and against each choice, but if your motivation is high, generally sooner is better, especially if your goal is a Ph.D.

Don't sell yourself short: if you are a high-achieving undergraduate, then you have the potential to be a very successful graduate student. Be prepared to work hard, but don't be afraid to accept the challenge.

# Applying to Graduate School

It is usually wise to go to a different school from your undergraduate institution in order to gain an alternate perspective. Personal reasons might limit your flexibility, though, and staying at your strong undergraduate institute is not a disaster.

If you are not restricted to the immediate area, apply to your undergraduate institution as a backup, but consider a variety of top departments. For example, environmental science students interested in environmental chemistry might consider UC Boulder, where a field biologist might consider UNC and a Geologist might consider Stanford or MIT. A truly interdisciplinary student might consider Arkansas State or Stanford's new EVS program. Even better, talk to a faculty member who does research in an area that interests you and ask for advice about the best schools in that particular subject. The list is often quite different from the list of strong departments overall.

Departments are ranked in a (quirky) yearly survey by *U.S. News* and by publications of the National Academy of Sciences.

Apply to several departments: there is an element of luck in the admissions process, and for each research interest, there are a number of strong schools that are good choices.

## 1 How Do Schools Choose Their Students?

The application process provides a tremendous amount of data to a department admission's committee, but people who have served on such committees can tell you that there is still a large element of uncertainty in sorting out the strongest applicants.

Different departments put different weights on the various components of the application, but here is what an "ideal" application might look like:

- A strong undergraduate record, with a substantial number of advanced courses in the mathematical and computer sciences, and a good number of A's in these courses.
- Letters of recommendation by trusted colleagues. (It is only human for an admissions committee member to say, "Prof. X wrote a strong letter for Z last year, and Z is doing well here. I can trust what X says about students this year," or "Prof. X is a leader in the field, so I can trust X's assessment of whether this student can succeed in our graduate program.")
- GRE scores that indicate past achievement.
- At least a modest number of outside activities and interests that indicate a well-balanced individual.
- An essay that is well-written, that discusses previous accomplishments, shows motivation, and specifies some goals, even if they are somewhat vague.

## 2 Making a Decision

Suppose you are in the lucky position of being accepted to more than one graduate program. How can you decide which offer to accept?

- Think about what factors are important to you. The strength of the department should be high on your list, but you also need a place where you can feel comfortable enough to function well. Make a list of what is important, and then try to find out how the candidate departments measure up.
- Gather as much information as you can--graduation requirements, lists of courses currently offered (as opposed to those officially in the catalog but never taught), lists of faculty and their research interests, staff benefits (insurance, etc.), syllabi for courses and exams, etc. Much of this information should be available on the Web.
- It is becoming quite common for admittees to visit various schools before making a decision. Some departments even pay for part of the expenses of the visit for their top candidates.

Let the department know when you plan to arrive. Arrange to tour the facilities and talk to one or two professors and a few graduate students.

Wander around on your own, too. Visit the computer labs, the library, the bookstores, etc. Get a feel for how well the department and the school function.

Ask lots of questions--about the program requirements, the research strengths, the climate for graduate students, housing--about whatever is important to you. Trust your instincts: if the department feels wrong for you, it may well be!

- If you cannot visit in person, ask the department to arrange a phone interview with some faculty members and graduate students. E-mail can also be used for this purpose.
- Talk to the people who wrote letters of recommendation for you. It is a chance to thank them, to let them know that their letters had good effect, and to ask advice.