A Fisherman's (Cliff Notes) Guide to Grad School

This guide is not close to exhaustive, but simply focuses on the key activities each year.

Key theme for grad school: Grad school is about research, not classes. In general, when assessing productivity in graduate school, people will care far more about your research, technical and intellectual skill, and research productivity than they will about classes and grades.

Two keys to success in graduate school: work hard and have fun.

1) Work hard, think hard, do experiments. Work hard (40+ hours/week of good, hard, efficient work), think hard intellectually about what you are doing and why (read the literature, go to talks, talk to others about your/their work, and synthesize the information and relate it to your work), do experiments – biology is an experimental science, the more experiments you do at the bench for computer the "luckier" you get (as long as you think hard).

2) Have fun. You want to like the question (what and why), like the approach and experiments (how), and like the people you work with (who). You want to find a lab that draws you in: A lab you want to go to and work in even when your experiments are not working and you are bummed about research, which happens to most people at some point during grad school.

   When grad students come to me and are struggling for one reason or the other in the lab. I ask them: "When you get up in the morning, do you want to go to lab?" If they are in a good lab environment, they often say something like "Well, sometimes it's a little hard, but my labmates help me through it… or are supportive… or tell me this happens to everyone…or give me ideas…So, yes, I go to lab." When they are in a bad lab environment, they often say something like – "It's hard, but I can get through it." Or, "I can tough it out." In short, good lab environments promote positive feedback loops in terms of doing experiments/going to lab, and bad environments can promote negative feedback loops in terms of these activities.

Take home point: it's far, far, far easier to work hard, think hard, and do experiments, when you are happy and having fun. It sounds trivial, but it's closer to profound.

Year 1: Classes and Rotations:

Year one in graduate school is dominated by two activities – classes and lab rotations, with about a 50:50: to 30:70 split in time between the two activities shaded toward rotations. So, per week, 20 hours on each or 15 on classes and 25 in lab, assuming a 40-hour week. In most graduate programs, students take the equivalent of two full classes each semester during year one and spend the rest of their time on their lab rotation. Depending on the program and school, a lab rotation can be as short as a month or as long as three months, with two months likely being the average length of a rotation. The sole purpose of a rotation is to identify a thesis lab (in which you can excel). Most programs require three rotations, but allow the option of additional rotations if needed. Most programs also allow the student to identify the labs in which they will rotate, but some may choose for you (I would argue this is not ideal). A rotation is similar to what each of you is doing this summer – carrying out mentored research in a lab for 8-10 weeks. Essentially, students rotate through labs to see if they like the science and the questions asked, the type of experiments, the people in the lab, the faculty mentor, and the general way the lab is run (see "have fun" point

above). At the same time, regardless of what anyone says, the lab and PI also evaluate the student – does the student work hard, think critically, and fit in. All labs want grad students who are engaged intellectually and scientifically, and few labs want someone who will cause headaches. After completing their rotations, a student ranks their lab choices, meets with their top choice and asks to join the lab. The faculty advisor of the lab can say no, but almost always says yes. The analogy I use for rotations/thesis lab choice is the following: rotations are like dating, and joining a thesis lab is like a marriage. I think that identifying a good thesis lab, a lab in which you can excel, is the singular key determinant for success in graduate school (given that you then work hard, think hard, and do experiments).

Another big event that occurs at the end of year 1 for many programs is a General Knowledge Qualifying Exam that tests students on their first year coursework. For more detail see below in year 2.

My take on the three keys to success in year one of graduate school in rank order:

- find a lab in which you can excel (sustains you through grad school and beyond).
- develop a strong, student support network (sustains you through grad school and beyond).
- Get through classes and learn (gets you to year 2 of grad school).***

****If you are struggling in your classes, then they become more important and you should focus more attention on them.****

<u>Year 2: Finding your way in the lab and QEs</u>

Once you identify a thesis lab, the lab becomes your "work home" and your thesis research becomes your main focus, with most students spending 30-50 or more hours per week on their thesis research. This is pretty similar to what all of you are doing now in your labs over the summer. In addition to your thesis research, the other main focus of year 2 for students is to pass their program's Qualifying Exam (QE). The QE is a rigorous test that assesses a student's potential for independent research – in general they test both a student's general knowledge of their field and the student's ability to identify key unanswered questions in their field and design incisive experiments to address these questions via the writing and oral defense of a research proposal. QEs come in many different flavors; below, I outline one version of a QE that is broken up into two parts (see MGG Qualifying Exam document for all the details). First, students take a written (or oral) general knowledge exam that tests them on the core classes they took in year one (classes would typically focus on cell biology, gene regulation, genetics, etc.). This test is about 3 hours, and typically occurs at the end of the first year. Second, during the fall of year 2, students write a scholarly review of their field of thesis research, in which they identify key outstanding questions in the field and then propose a substantive set of experiments that addresses one of these questions (these experiments can be what they expect to do for their graduate thesis). The student prepares the written document with feedback from his QE committee chair and from others, and then defends it orally in front of three faculty members. In the oral exam, students give a ~25 minute presentation of the proposed area of research, its significance, and anticipated results and interpretations, and are quizzed by faculty. The exam takes 1.5 hours on average.

That's the gist of year 1 and 2. Lots of other stuff happens as well that I'm leaving out, such as TA, advising, work-in-progress talks, training in scientific presentation (practice talks and critiques thereof), optional classes students chose to take, outreach, a class on ethics, etc. If interested, see the MGG Training elements PDF for details.

Year 3: Research and thesis proposal

After passing the QE, technically a student has advanced to thesis candidacy. That is, they have completed all the academic pre-requisites in the program (classes and QE…). At this stage, the main focus for graduate students is their thesis research and related activities. For many students, their research and related activities represents their sole focus in graduate school. For other students, thesis research represents their main focus (>80-90% of time), but they may be involved in other activities aligned with their expected career goal. For example, some students may take on additional teaching responsibilities if they are interested in a teaching career, or they may work with BALSA (https://www.balsa.org/), if they are interested in a career in consulting, or the Young Scientists Program (http://ysp.wustl.edu/), if they are interested in outreach/teaching.

The other main event during year three (or late in year two) is creating your thesis committee and writing and defending your thesis proposal. What is your thesis committee? Think of it as a mentoring team. It's a group of 4-5 faculty members with whom you meet one or two times a year to get advice from on how best to complete your thesis research. You and your faculty advisor choose your thesis committee.

What is a thesis proposal? It's essentially a grant that details your proposed thesis research. It will provide a brief, focused introduction that highlights the question or hypothesis you are studying and why it's important. It will then propose two or three main areas of research to tackle the question (specific aims). Within each aim, the student will outline a set of experiments they will pursue to address their question and discuss what they expect to find, how they will interpret results, and why they think the results will be important (If people want, I'm fine providing one of my grants to give you an idea of what grants look like. Just realize the grant I provide would be equivalent in work to 3-4 thesis proposals). Anyway, before the thesis proposal meeting, the student provides the committee with the thesis proposal, then at the meeting gives a talk that outlines what they are doing and why and fields questions. In an ideal world, the thesis committee helps guide the student's progress through grad school via one or two meetings a year at which they update the committee on their research progress and get guidance. Honestly, I don't find most actual thesis meetings that helpful (some will disagree). What is helpful is the act of preparing for a thesis committee meeting, as it forces a student to think more deeply and critically about what they've done over the past 6-12 months, synthesize the information, and think deeply about the next steps. Also, committee members can be incredibly helpful if you need one-on-one help with specific experiments in their area of expertize.

Year 4 and up: Research, research, research

In general, year four and up are similar to year 3 with the following trend. As grad students get closer to finishing, they tend to focus more and more on research and less and less on other responsibilities, e.g. teaching or outreach. Research becomes the full-time activity and advancing the frontiers of science and knowledge is their goal. AKA – research, research, research.

Cliff Notes Guide to Graduate School Applications (in general true for summer research programs too and most any applications)

The following is what you need for most grad schools applications:
1) Personal essays
2) College Transcript(s)
3) GREs (for some schools)
4) Letters of recommendation

Grad school applications tend to be due Dec. 1 (main deadline), 15, or Jan 1. The applications themselves open around Sept. 1. It's not like med school where getting your application in ASAP is important. But, it does not hurt and may help to get your application in a little on the early side - i.e., early-/mid-November, as some programs will start reviewing applications in mid-/late-November. I'm not a fan of this, but they do it.

1) Personal essays: In essence, your essays should address the following questions: Why do you want to go to grad school, what is your prior research experience, what do you want to study in grad school and why, and is there anything else we need to know about you that you did not tell us (this last question is optional, and only need be addressed if you have extenuating circumstances that they should be aware of or that may explain issues with grades etc. If you do, it's fine to tell them, wording with these types of things can be tricky so ideally get a faculty member to read it. What types of things might qualify as extenuating circumstances or what types of things might you want to explain? If you take a year off of school, I'd explain that. If you had to work 20 or more hours a week and believe your grades suffered as a result – that would qualify. If you struggled in transitioning to college for various reasons, but then got things straightened out, you could mention that especially if your early grades were so-so and then improved.). Clearly, more to it than what I just wrote, but that's the gist of it.

In your essays, personalize the essay to each school to which you apply. For example, if it's your top choice or a top choice, tell them. For all applications, tell them which faculty you are most interested in working for at their school and why. The "personalized" section need not be more than a paragraph or even a few sentences, but it should be there. Tell them why you want to go to *their* program for grad school. And, tell your letter writers, which programs are your top choices, as they can put that in their letters too. It won't hurt.

Also, I would strongly encourage everyone to get feedback from faculty members on your personal statement. In general, the more feedback you get the better, but faculty members are the best people to get feedback from, as they sit on admissions committees and thus know what admissions committees are looking for.

2) Transcript/grades: In general, grades are what the grades are.
Classes to consider for grad school? My advice is that it's helpful for all entering grad students to be proficient with computers and know how to code at a basic level: downloading files, writing computer scripts to link programs, etc. I don't know much, but I know that datasets will only get bigger, and those researchers who can interrogate and mine large datasets for biologically important information will be at the forefront of science, especially if they can also think

experimentally. So, I would argue an Intro Comp Science class is important, and if you like computer science, then more is better. Other than that, what classes you take will depend on your field with biology, chemistry, math, and physics, being staples for most students, but there is great variation in the classes students take. Honestly, the one thing that most science majors overlook is the absolute importance of being able to write well (and ideally quickly). So, any class that helps you write better will help with grad school as well. I can't stress that enough.

3) GREs - There's a growing trend to make GREs optional or not require them at all. So, some schools may not ask for them or want them, but some schools are still likely to require them (but check again when you are applying in two or more years as the pendulum is in motion and swinging against the GREs. Now, there may be a reversal of this trend, but that won't happen for 5-10 years, if it does at all). In general, the more quantitative the program, the more likely they are to require GREs – think Computational Biology and Biophysics. The same is not true with MCATs. There appears little push to get rid of MCATs, even though I would argue they are weighed far more strongly by admissions committees, have a far greater financial barrier than the GREs (which do have a financial barriers), etc.

How to prep for GREs? Depends a bit on how you learn and how you take tests. For me, I need to get into a specific mindset to take standardized tests (or at least to take them and do well on them). To get into this mindset, I need to take lots of practice tests. Before I took the GREs, a year or two ago now…, I think I took two weeks and did a practice test or two most nights, for maybe one or two hours. Maybe it was a week, maybe three weeks, but two is fairly accurate. I took practice tests until I knew I was in the mindset of taking these types of tests: Ie, I knew how they asked questions and what they were looking for in the questions.

What's new since I took the GREs is that they are now done on the computer (we did have computers back then, but not tests on computers (THANK GOD…). Personally, I don't like this, and I would score far worse on a computer test, but it's how they do them now. So, I would take some practice tests on a computer, so that you can get used to it.

4) Letters of recommendation - they will ask for three (and may allow more). The most important letters of recommendation are from your faculty research mentor(s). I will repeat that. The most important letters of recommendation are from your faculty research mentor(s). As I said, grad school is about research not classes. Admissions committees will weigh letters of recommendation from faculty members in whose lab you worked far greater than those who had you in a class or two. If you have two significant research experiences and both faculty members will write you positive letters, go with them.

A key thing with letters is to give the faculty member ample lead time to write your letter of recommendation; ie, give them a month or two lead time, not a week or two. For example, if you are applying this fall, then I would ask your summer program faculty advisor if they can write you a positive letters of recommendation toward the end of the summer program. For those faculty at your home school/different institute, I would ask them in late August/early September. In addition to giving faculty members ample time to complete their letters, I would also encourage you to provide them with your personal statement, grad school essays, and transcripts, which will allow

the letter writer to be more specific and concrete about your past research, why you want to go to grad school, etc.

Application Review Process

At most schools, the application review process starts in mid/late-November (even with a December 1 deadline, so in general it does help to get the application in a little early). In most cases, all applications are reviewed by two to three faculty members who sit on the relevant admissions committee. At weekly Admissions committee meetings, committee members discuss each applicant and decide whether to invite for an interview, not invite, or essentially put the application on a wait and see list to see what the rest of the applications look like. On average, for the programs that I run, which are decent proxies for most programs here and at other schools like us, we interview about 30% of our domestic applicants. Now, places like Harvard, Stanford, MIT, likely interview 10-20% of their domestic pool, as their pool is likely bigger than our pool.

Interviewing for Graduate School

Assuming you are invited for an interview, most graduate programs host interview weekends for prospective graduate students. What happens at these weekends? Well, it varies a bit based on the program/school, but they are all more or less similar. Interviewing students typically fly in on Thursday afternoon/evening and then leave Saturday afternoon. Below is a verbatim email that I send to students interviewing for the Dev Bio program that outlines the details of the visit (the email I send to Genetics students is essentially identical).

Dear XYZ,
My name is Jim Skeath and I am co-Chair of the Developmental, Regenerative and Stem Cell Biology (DRS) Program at Washington University in St. Louis. We are excited about your upcoming visit, and I wanted to touch base with you prior to your visit to give you a brief overview of the 'weekend'.

On Thursday night after you arrive in St. Louis you will go out to dinner with a number of current students in the DRS PhD program to a local restaurant. The dinner is informal (no faculty will be there) and serves as a good way for prospective students to ask questions to current students about the DRS programs, Wash U, and/or St. Louis. On Friday, you will interview with 4 or 5 faculty members - usually three before and two after lunch. You will also attend a general introduction to the DRS Program and the Division of Biological and Biomedical Sciences first thing Friday morning. After lunch with students, you will go on a tour of the zebrafish facility and an imaging facility. After your last interview, there will be two 15-minute 'Work in Progress' talks given by current students in the program about their work (a 'Happy Hour' follows the talk). This is a regularly scheduled event for the Program/Dept.

After some downtime, I will host a dinner at my house for all prospective students to which many current students and faculty members will also come. These dinners are relaxed, low-key, and informal events (e.g.: ping-pong and darts downstairs). After dinner, current students will take you to the City Museum (http://www.citymuseum.org/about.html), an eclectic, interactive, and internationally recognized "museum" – think ten story jungle gym. The more adventuresome will

likely find they are crawling through tunnels, sliding down a ten-story cork-screw slide, and the like; *thus, it is appropriate to and recommended that you dress informally to dinner*. The City Museum also has a number of lounges/bars for those who would prefer simply to sit around and chat. It really is a fun, entertaining, and unique experience. Saturday consists of a tour of St. Louis, featuring looking at a few student apartments, lunch, and then a return to the hotel where you get a shuttle to the airport.

You should receive your itinerary/interview schedule from Sally Vogt shortly (if you have not already). We try our best to match prospective graduate students with the faculty members they requested. But, due to the number of students interviewing on any given day, some faculty being out of town, and the relatively packed nature of faculty members' schedules, we are sometimes unable to match students with all of their top choices. Thus, if a faculty member with whom you would really like to talk is not on your schedule, please let me know, and I will try to see if they can make it to the happy hour on Friday or the dinner at my house (or something like that). I can't promise success on this front, but I can promise that I will try.

I hope this email gives you a flavor of your upcoming visit to Washington University. Safe travels, and please do not hesitate to ask me any questions you may have about your upcoming trip.

Thanks and I look forward to meeting you on Friday.

Jim Skeath

What happens after the interview?
After the interview, typically the admissions committee will meet the next week to discuss the applicants (or if we have another group coming in the next week, they may wait another week). What do they consider? They discuss each student's application and also the comments for each student made by those who interviewed the students. Please note that all faculty members who interview a student are asked for feedback on the student – ie, a write-up and a general ranking. This is true with all schools, though exact details differ on feedback, rating systems, etc. After a discussion on each student, the committee will vote to accept, reject, or hold. If you are accepted, the school notifies you via phone and email. On average, most schools accept about 70-80% of the applicants they interview.

I think that's about it.