Graduate School Advice for Post-Bacs

Please note that everyone's graduate school experience and program is different. All timelines, goals, and expectations may vary greatly depending on your program and field of study. The information that follows can be thought of as a foundation which will need to be molded to fit your specific circumstances.

Applying to Graduate School

- Most STEM PhD programs come with a tuition waiver and stipend (Master's programs generally do not).
    - These stipends can vary quite a bit depending on location, department, and program. As mentioned below, a good idea is to talk to current students to learn if the stipend is enough based on local cost of living.
    - The tuition waiver and stipend may require you to teach undergraduate labs or recitations. Depending on your career goals and personality this could either be a good thing or not. But it universally takes up more of your time so if you are offered a teaching assistantship keep in mind that it will be harder to focus on course-work and research.
- Most STEM PhD programs allow you to get a Master's degree without applying for it (usually just paper work). So it usually gives you more flexibility to apply to PhD programs, get funding (see above), and then after a few years if you don't like the work you can always finish up the Masters and skip the PhD. Conversely, if you apply and are accepted into a Master's degree then you will have to reapply to move into a PhD program.
    - Note that graduate school can be very different abroad! In Europe, many places require a master's first. In Australia, some places don't even require coursework, or have very little coursework. If you are thinking of studying abroad, make sure you do your research!
- Reach out to potential advisors ***before*** you start applying. Have quick chats where you ask about their research, their goals, **if they're taking on new students for the term you're applying for**, and if you fit in there or if they have suggestions on where to apply; it's hard to build a list of potential schools and advisors, but by talking to one person, they can suggest a few names, and those names can suggest more, etc.
- **Reach out to current or recently graduated students** as well to get a feel about life in that graduate program and with a particular advisor. Ask about the stipend, benefits, cost of living, likes and dislikes. This will give you a good idea of whether you can see yourself there. Remember: this is essentially a job application, and you need to make sure *your needs* will be met and you will enjoy spending 5+ years at that institution.
- When writing your research statement or statement of purpose, think of it as a persuasive essay where you're convincing an employer to hire you. Show the admissions committee that you're the best person for their department, *and* that their department is the best one for you. Before you send it in, it's a great idea to have folks review your statement --- especially professors at your undergraduate institution who have served on the admissions committee there, or current professors/staff scientists at the institution to which you're applying.
- If you have done research as an undergraduate, or in a masters program, don't feel that you have to stay in the same field for a PhD if you are interested in a different type of science (even

if you have publications already). Your experience doing any type of research will be beneficial to success in a PhD program, and marketable in your applications.

- Other, non-research projects you have worked on as an undergraduate are probably worth mentioning in your application. Have you built some software or app? Have you hosted talks, seminars, journal clubs? Have you done any sort of teaching or tutoring? Etc. All of these are skills and experiences that are very applicable to graduate school and a research career.
- Don't go into it thinking that you're going to spend the next decade languishing in a corner eating ramen! The stereotype doesn't need to be reality. You can finish coursework in 2-3 years, and if you're working with data or a model that's already readily available, you can be done with your project and have your thesis written in another ~2 years. If you think about it more like a job with well-defined tasks than an open-ended school program, it can help you to stay disciplined.
- **Applying to graduate school can, unfortunately, be expensive:** In the past many graduate schools required GRE tests (both general and subject specific). Lately many programs are dropping at least one of these requirements but you will want to check first. The GRE tests can be over $100 each and depending on your scores you may want to retake them. Also if you take a prep class or buy study books, those can also increase the cost. Lastly, the grad school applications themselves can cost $30-120 each!
    - There is not too much advice to give about this. It is really bad that the cost just to apply to grad school is so high. The best you can do is to save up money early on and just be prepared to pay a lot.
    - If you have the time and money, it is recommended to plan on taking at least the subject level GRE 2 or more times. For the Physics GRE the topics can vary a lot and may even go into topics you didn't cover in undergrad. By taking it twice or more you increase your chances of seeing more topics you are familiar with.
    - **You are not your test scores!!** Do not feel bad if you did not get what you were hoping for on any of these tests. Test taking is *very* different from actual research. Honestly it is a bad metric to determine who is admitted to grad school, but we are still stuck with it for the time being. Emphasizing any undergraduate research and activities is a good strategy to overcome bad scores.

Questions to ask Potential Advisors

- Find a good advisor as soon as possible, their advice throughout the grad school process is priceless, and it will save time when you're trying to find a thesis project. It's not just important that they be in your field; you need to have the same kind of work ethic and compatible personalities (they can't be so gentle with instructions that you don't know what they're asking for, nor should you be confused or upset by their method of giving constructive criticism). Don't be afraid to shop around or change advisors if the first one doesn't work out!
- What their research is, what their research goals are for their lab/group, and what their non-research goals are for their lab/group and department (things like eliminating the GRE, getting a higher grad student stipend, etc.)
    - Basic information about the type of research, if you are not familiar: is this field work? Lab work? Computer modeling? Will you spend most of the day on a computer or in a lab on your feet?

    - Will you be working with other graduate students / post-docs often?
- What is the timeline for the PhD program? (Typically, it's 2 years to a master's, do your qualifications, then about 3 years of research, and you defend.) What proportion of students complete the program, both in the expected timeframe and more generally?
- What do they look for in a PhD student, what projects would they like to see their students take on, and what timeframe do they expect a project or sub-project to completed by. This can give you a sense if they expect too much out of their students. Do you have a publication requirement? How many papers do students typically publish?
- Does funding cover the summer as well? Does funding include a travel stipend? If funding does not cover the summer, how successful have prior students been at obtaining some other source summer funding?
    - Some programs will state they offer an "annual" stipend when in reality it is a 9-month or "academic year" stipend.
- Where do students usually go after their PhD from this department? What kind of jobs do they typically take?
- If you have other interests such as work in policy, outreach, D&I, teaching, etc., ask your advisor if you'd be able to continue those interests.
- Ask questions specific to your situation. This can be disability accommodations, what tools they use for projects (programs, coding languages, facilities, etc.), if there are local institutions you can do work with (for example Johns Hopkins and APL, Stanford and NASA Ames, UMD and NASA Goddard, etc.)
- Who are some of their past students? Talk to them and see how long they took to graduate, what their mentorship experience was like, how easy/hard it was to get papers done, etc.
- Will you have the opportunity to be part of any wider collaborations, either within your advisors group or with colleagues at other institutions?
- Are there any missions or major projects that they or their team is apart of? Would you be able to contribute to project(s) related to these missions.

Beginning of Graduate School

Roughly the first one to three years when you are deep into course work.

- Because it is so important it is worth repeating: Find a good advisor as soon as possible! See the section above.
    - Make sure to learn what other groups are working on in your department. You never know if you may find another project more interesting than the one you originally applied for.
- Make friends with others in your courses, meet with them outside of class and work on problems together. People's learning and thinking styles are different so it can be helpful to have new perspectives. At the same time always make sure you are able to solve the same problems on your own.
    - Learn if the department, college, and/or university has any graduate student associations or clubs that you may be interested in joining.

- If you are a graduate teaching assistant it will be very important to manage your time. Everyone is different, but some have found it useful to look into time tracking and to-do list management apps to make sure they are not letting one task or project dominant their time. If you are teaching many students (the average can vary but ~3 classes of 20-30 students each per semester is not unheard of) then grading work can easily get out of hand if you fall behind.
    - Don't be afraid to ask your supervisor and/or other TAs to cover a class(es) for you if it would allow you to attend an important research conference or if you just need time off to deal with an illness or other issue.
    - For labs, always make sure you understand exactly how an experiment is supposed to work. Generally the department will have someone else whose job it is to setup the lab experiments, but make sure to have their contact information in case there is ever a problem.
- Professors for graduate course work tend to be more approachable and willing to work with you than in undergrad. Always reach out to them if you feel like you are not understanding something.
- There are generally less exams and more homework / problem sets during a semester of graduate school compered to undergrad. This can be either good or bad depending on your learning style.
- This is a great time to explore the local area and culture. You will want to know of quick ways to escape from your classes and research when you need a break. This could be checking out the local bar and restaurant scene, hiking trails, museums, whatever!

Advancement to Candidate

Roughly the third or fourth year when you are taking qualifying exams and finishing major course work

- Qualifying exams vary greatly from program to program. Some are physical tests taken over the course of an hour or two. Some are oral examinations usually given by your dissertation committee or department's graduate advisor. Some are combinations of the two. They could be focused on topics related to your research or they could be general examinations of core course work like classical mechanics, quantum mechanics, electrodynamics, thermal/statistical physics, etc. --- even if one or more of these topics is not applicable to your work. Most programs allow you to retake exams that you do not pass, but there is generally a time limit (measured from when you entered the program) where you must successfully pass the qualifiers to advance to candidacy. It is important to learn what the consequences of failing an exam are, how many times you can retake, and if there are any time limits based on admittance year.
    - Because of how different these exams can be, it is hard to recommend the best way to prepare. But it is generally the case that the department does not want you to fail as it is also a partial reflection on their ability to prepare you. So, many departments will offer resources like previous years exams. If yours does this then definitely take advantage! There have been instances where questions from a previous year's quals reappear in a slightly different form in future years! Also reach out to students who have completed their quals to learn the format (What is the time limit? Are text books allowed? Are notes allowed?). If it is a written exam then general exam tips apply: If you get stuck on one problem don't let it consume all your time --- skip it and come back, even if you

don't know the full solution write down what you know for partial points, don't be afraid to ask the examiner for clarifications on a question, etc.

- Once you have completed your quals (congrats!) your program may require you to do a "research proposal" or "proposal defense" in fact they may have required this before you took your quals. Again these can vary greatly, but generally the point is to produce a written and oral presentation of your thesis topic and what you plan to do for your thesis. This usually takes the form of a presentation to your dissertation committee and a short written report. In it you will want to describe very briefly the background on your scientific question(s), what has been done to address them in the past, what you / your group are planning to do. You will have hopefully been talking to your advisor for a while at this point, so there should be no surprises from either side of the table.
- At this point you most likely have completed all the bureaucratic steps to becoming a PhD candidate! Make sure to check with your department early-on on what documents you need to have signed (this signing is usually done at your proposal defense). From this point on you should be focusing on your research and only taking classes that absolutely benefit that research (most people do not take classes any more and instead take "research credits").
- There are a few tips that are important early on in your thesis research:
    - Figure out a system for keeping notes, keeping track of articles, tracking results, and writing papers. This could be as simple as a folder organization system or a system that utilizes an app like Mendeley or EndNote.
    - A lot of theses end up being a combination of any papers you submitted + additional background. So whenever you are finishing up a paper make a copy in a new document that will end up being a chapter of your thesis. Make edits to make it make sense and not reputative with the rest of your thesis' structure. Doing this early will save you a lot of time later.
    - When you make important figures throughout your research (either for publications, presentations or just day-to-day work) make sure you save the script that you used to produce it. You will thank yourself when you come to put it into your thesis potentially several years later, and want to make edits to it etc.,
    - This is a great time to start building out your next step! Make a personal website to showcase you and your work. Keep CV updated. Get business cards. Learn about post-doc or industry positions. You will have to do all of this your last year anyways, doing it now will save you from doing it AND defending your dissertation at the same time.

Completing and Defending Dissertation

The last year or two of your program where you are writing your thesis and preparing for the defense.

- First some definitions:
    - Your "thesis" is the document that contains your research background, methods, contributions, and references. The length of a thesis is totally up to your research, your advisor, and you! Feel free to look at others an example, but don't panic if yours is way longer or shorter. In the past few decades they have trended towards being longer (150 to 250 pages) but there is a lot of variance. Theses of the far past, think 1800s, could be as short as 7 pages!! Just like your papers, focus on keeping it concise but covering all of your accomplishments and the relevant background and references.

    - A “dissertation defense” or “defense” is often referring to a presentation followed by Q&A that takes place near the end of your program (usually some time in your last semester). This presentation is primarily to your dissertation committee (3-6 professors or scientists with one being your PhD advisor, some may be external to your institution. You will pick your committee before your proposal defense, see above), but may be open to the general public. The presentations can vary but generally include ~45 mins to an hour presentation by you going over the highlights from your thesis, followed by a questioning period. The questioning period will have a private portion with just you and your committee. This portion can vary a LOT depending on your committee and chair. Ideally they will ask you questions about your research topics. However, it is not unheard of for committee members to ask general science questions maybe even ask you to solve problems on the spot. Try not to focus on that though. Your research contributions should be the focus. It is a good idea to touch base with your committee members and other, former students who have had the same members in the past to ensure there are no surprises.
- Writing your thesis and defending your dissertation can be very different from your expectations and others experiences:
    - *Don’t underestimate how long it will take you to write your thesis.* You might be tempted to think that you don’t have enough material to write up, but if your advisor says that you do then trust them and start writing!
    - Don’t assume that it will take you as long as your classmates/previous students of your mentor. The amount of time it takes to write your thesis is essentially only up to you – the more motivated you are, the less time it will take. It is possible to write an entire dissertation in less than a year.
- By the time you defend your thesis you should already be thinking about the next steps and may have already started applying to jobs or post-doc positions. For post-doc positions, just like applying to graduate school, it is better to start talking to a potential advisor before applying to a fellowship or position.

Differences between US and International Graduate Programs

United Kingdom

While this section concerns the UK graduate school system, many European systems share commonalities and similar differences to the US system.

- While a department may have UK Research Council (e.g. EPSERC, STFC) funding available for PhD programs (often referred to as studentships), covering both stipends and a tuition waiver, there is usually a cap on how many non-UK/European students can be granted such funding. If you see an advertised PhD position than promises UKRC funding then check with the point of contact as early in the process as you can to determine if you are eligible.
- If you are not eligible for UKRC funding, then there often scholarships from the Universities that you and your potential advisor could apply to instead. Or they may access to some other source of funding without residency requirements.
- Once you have funding, it covers you full time, you don’t need to find summer funding.
- PhDs last 3-4 years, and pretty much only require research. UKRC funding typically lasts 3.5 years, with the expectation that the final 0.5 years is your writing up period. Unless you join a

combined Masters+PhD integrated program then you likely won't be in a program requiring a dedicated 1-2 years of classes. Some programs may include some number of both optional or compulsory graduate level classes but these are generally not full-time and you would do these while also working on your thesis research topic. They are not as onerous as the qualifying/comprehensive exams in the US system.

- While the base requirement for entry is usually an upper-second (2:1) BSci honours degree (https://en.wikipedia.org/wiki/British_undergraduate_degree_classification) or equivalent in a subject related to the PhD, you may need a masters for applying to competitive programs. You will probably have to contact the University directly to ask how they convert a US GPA to the British classification as this will vary somewhat between schools.
- At the end of your program you will need to write your thesis, which is defended in a *viva voce.* There are only two examiners, usually one internal to your department/University, and one external expert in your field. You will meet with them for around 2-3 hours give or take in a closed-door meeting, and answer questions about your thesis and general knowledge of the field. Following your *viva* you will be asked to make certain corrections (either major or minor) which are then approved before your PhD is conferred.
- Typically, instead of applying to a group/lab and finding your advisor later, you apply to an advertisement from a particular faculty member (usually listed on department webpages or newsletters). The general aims of the PhD research topic will be clear from the outset, as is the person you will be working with. Of course this doesn't mean that the research direction won't change as you actually work on the PhD, but you will know your general topic and goals when you start.
- While you are paid a stipend to do your PhD research you might also be expected to do some small amount of teaching (a few hours per week). This is typically paid hourly on top of your stipend (not a lot but it helps). I'm not sure if it is compulsory at all Universities but some do try to enforce that you teach for X semesters during your PhD. These roles might be as a lab demonstrator, or helping with class tutorials etc., but it is unlikely that you would be asked to lecture.