A GUIDE TO GRADUATE SCHOOL IN THE BIOLOGICAL SCIENCES

Prepared by the faculty of Towson University's Department of Biological Sciences

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A Note to Students and Faculty at Towson University and Other Colleges and Universities

I very much welcome comments, corrections, and suggestions for improvement of any kind. An updated version will be created each August, and posted at the Towson University – Department of Biological Sciences website: http://wwwnew.towson.edu/biology/.

Best of luck to you with graduate school!

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What is Graduate School and Why Would You Want To Go?

After completing a B.S. degree in Biology, you may want to attend graduate school to receive additional training and ultimately an advanced degree, either a Master of Science (M.S.) degree and/or a Doctor of Philosophy (Ph.D.).

People go on to graduate school for many different reasons. For some, obtaining an advanced degree, especially an M.S., is necessary for promotion or higher pay in their *current* profession. These individuals typically enroll in a "non-thesis" M.S. program, which involves coursework only (no major research projects). After completing 30 or so credits of advanced coursework, they have their degree.

Another reason that people attend graduate school is because an advanced degree is either recommended or required for the career that they want. In many career areas, a B.S. degree only qualifies you for an entry-level position, which often involves doing primarily grunt or "go-for" work for those individuals that *do* have advanced degrees. To obtain higher-paying, more interesting, decision-making level positions, you may need graduate-school training.

Finally, people go to graduate school because they want to study and explore some particular area of Biology in more detail. However, many undergraduates mistakenly assume that "grad school" is just more of the same, i.e., *more* classes and *more* tests (but probably a lot harder). Yes, some coursework is involved in getting a graduate degree but the difference is that you take primarily courses in <u>your specific area of interest</u>. For example, a student may come to TU *generally* interested in the biology of animals. After taking a number of undergraduate courses, the student discovers that they are particularly intrigued in how animals adapt physiologically to different environments. If this student heads off to grad school to study "ecological and evolutionary physiology" in more detail, they will take graduate courses almost exclusively in the areas of physiology, ecology, evolution, and closely related fields. These courses will often be taught by professors actively doing research in these areas. Moreover, the structure of graduate courses usually differs from that of undergraduate courses. Much more time is spent "on the cutting-edge," i.e., examining new and exciting discoveries. Many of your assignments will be to read articles from the primary literature and class time will often be spent discussing and debating the implications and value of the methods used and the results reported in these articles.

Note also that taking additional coursework in one's chosen area of interest is usually just a small part of the graduate experience. One's main focus in graduate school is *conducting original research*. Under the guidance of a professor who is an expert in the student's chosen area of interest, graduate students do research on questions that nobody has ever studied before. The results are written up in a "thesis" or "dissertation" and are normally published in scientific journals. There is nothing quite like the thrill of making an original contribution of new information to one's favorite area of Biology.

The M.S. vs. the Ph.D. degree

If you do decide to go to graduate school, one of the biggest choices that you will face is whether to get a Master's (M.S.) degree, a Ph.D., or both, i.e., complete an M.S. and *then* a Ph.D.

In large part, your decision will be determined by what you want to do for a career. Some professions only require and expect individuals to have an M.S. Other professions require a Ph.D., leaving students to decide whether to get an M.S. before completing the Ph.D. For some careers, one can get into the career with either an M.S. or a Ph.D. degree, however, with a Ph.D. you will have greater status, i.e., be more likely to be in a supervisory/decision-making role, and you will earn a higher salary.

Your decision as to whether to do an M.S. or Ph.D. or both will also be affected by how much time and effort you are ready and willing to put into getting an advanced degree. Completing a Biology Master's degree usually takes 2–3 years whereas a Ph.D. takes 4-6 years. If you are not absolutely certain that you want to devote 4-6 years of your life to graduate school, you are strongly advised to start with an M.S. degree and see what graduate work is like before making a bigger commitment.

Even if you *are* certain that you want to get a Ph.D., you may still want to consider completing an M.S. before going on for the Ph.D. Or not. If you ask around, you will find that some of your professors strongly feel that completing an M.S. first is a wise move. Others will tell you that if you are certain you want a Ph.D., the M.S. is something of a waste of time. Arguments for and against completing an M.S. before the Ph.D. appear below. Ultimately, you will have to decide what is the best strategy for you. This is a big, big decision and one you should talk over with several of your professors.

Some reasons why you might want to do an M.S. degree before the Ph.D.

1) When you finish your doctorate, you will be competing with many other Ph.D.s in your field for jobs. Employers will mainly be interested in two things. First, they will look at the skills that you have acquired during your graduate training. Because your M.S. and Ph.D. research projects will likely be different, doing both degrees gives you the opportunity to learn a greater variety of skills. Second, they will look at your ability to do work/research and "produce" new findings. As an indicator of both your abilities and your work/research potential, employers will review the nature, number, and quality of scientific publications that you have produced. You are likely to have a larger number, and perhaps variety, of publications if you have completed two graduate degrees.

2) Doing an M.S. degree first also gives you extra time and opportunity to do research and learn how to do research. Research is not easy, and there are many skills that one must acquire to be successful. One gets better and better at research with practice. If you choose to go straight into a Ph.D. program, the pressure is very much on you to succeed at what will probably be your first try at conducting a major research project. Doing an M.S. degree, and specifically a Master's thesis, gives you a chance to learn the basics of research with a smaller scale project. Moreover, a good record from an M.S. program, including one or more publications, should enhance your chances of gaining entry into, and succeeding in, a high quality Ph.D. program, one that might have been out of your reach as an inexperienced undergraduate. Conversely, if you run into some trouble with your

Master's research and you are not able to publish your research findings, all is certainly not lost! You have gained valuable experience and wisdom that you can take into a Ph.D. program. In short, you get a second chance.

3) Completing a Master's degree first allows you to spend a few extra years in graduate school. Most professors will tell you that the years that they spent in graduate school were some of the best years of their lives. You don't make much money, usually just enough to live on, but otherwise life is pretty good. Almost all your time is spent studying and researching subjects that are of intense interest to you. You are surrounded by other graduate students who are keenly interested in Biology and what you are doing. Many of these people will become life-long friends.

4) Doing an M.S. degree first can allow you to see more of the world, if you choose to do your Master's at one institution and your Ph.D. at another. Imagine, for example, doing your undergraduate at TU, your Master's at the University of Alaska and your Ph.D. at the University of Miami!

Why you might want to go straight into a Ph.D. program

1) As indicated above, one of the benefits of doing an M.S. degree first is it allows a person to gain experience doing research. This usually enhances one's chances of success when one gets to a very serious, research-intensive Ph.D. program. Some professors would argue that the M.S. degree is redundant and unnecessary for those students who have had extensive experience conducting research as undergraduates; such students should be ready for a Ph.D. program. To some extent, this depends on how "extensive" the undergraduate research experience was. It is probably fair to say that most undergraduates do not get near as much training in research techniques, data analysis, and scientific writing that they get in an M.S. program.

2) Graduate school can be an exciting, fulfilling experience but graduate students get paid very little and being poor gets really old after a while. It is also extremely difficult to raise children on a graduate student salary. The sooner that you can complete the Ph.D., the sooner you can move into the job market and start making real money…assuming that you are competitive. As argued above, completing an M.S. degree can make you more competitive for jobs in several ways. The question then becomes: Will completing an M.S. degree first enhance my competitiveness enough that it is worth the extra time spent not making much money?

3) Certain graduate schools only admit students that intend to pursue a Ph.D.; they have no formal Master's program. At these institutions, students enter a Ph.D. program and, after two years of coursework and preliminary research, take qualifying examinations. Students who pass these exams are automatically given an M.S. degree and allowed to go on to complete the Ph.D. degree. If a student does not pass the qualifying exams, but has successfully completed a certain amount of coursework, they are given a Master's degree as a sort of "consolation prize" and then shown the door.

Financial Support: Teaching and Research Assistantships

One reason that many undergraduates hesitate to consider going to graduate school is that they feel they don't have the money and don't want to incur more debt (e.g., student loans). This is unfortunate because, in reality, for most students, *it should cost very little to get a graduate degree*.

A quick clarification is in order: if you choose to do a "non-thesis Master's degree," i.e., just take enough graduate courses to get an M.S. degree (usually done to obtain a promotion or salary increase at work), you (or your employer) will have to pay for your schooling. However, when you do a thesis/research-based M.S. or a Ph.D., some form of financial aid should be available to make it possible for you to go to school. Indeed, you should not enter a research graduate program unless it provides you with a substantial amount of aid.

Financial aid for research-oriented graduate students generally comes in the form of a **graduate assistantship**. There are two types of assistantships, *teaching assistantships* and *research assistantships*. Both pay you a stipend or salary, usually just enough to live on in the local economy (usually $12000-$24,000 depending on the location; possibly more if you are in a Ph.D. program), and both come with a full tuition waiver (in-state or out-of-state). You still have to pay fees and pay for books, but that is all.

If you have a teaching assistantship or "TA," then in exchange for your stipend and tuition waiver, you will be assisting professors in teaching laboratories, usually in non-majors courses or lower-level majors courses (like BIOL 110, 201, 202, 213, 214, and 315 here at TU). You give lab lectures, run the lab, grade lab reports, make up and grade quizzes, and often assist the professor in grading lecture exams. You are expected to devote an average of about 20 hours a week to teaching. The rest of the time is yours to take courses and do research.

A research assistantship or "RA" is a coveted position because you are essentially paid to do research. You may get paid simply to do your thesis or dissertation research and, in some cases, some extra research that a professor wants done.

When you apply to a graduate program, you should indicate that you want to be considered for both an RA and a TA. Competition for such positions can be intense and awards are usually based on a student's qualifications (GPA, GRE scores, letters of recommendation, past research experience and productivity – see below). In some cases, schools will admit you into their graduate program but not offer you an assistantship. Again, we strongly advise that you *not* enter any program without an assistantship (unless you are independently wealthy or have a spouse or other individual that will cover your costs). It is nearly impossible to work enough hours at an outside job to support yourself while still devoting enough time to your coursework and research to be successful. For this reason, you absolutely want to apply to several graduate schools in an effort to find one that will both accept you *and* provide you with financial support.

Financial Support: Fellowships

Another way to support yourself in graduate school in whole or in part is to get a grant or a fellowship from a private foundation or a government agency. For example, the National Science Foundation awards "full-ride" Graduate Research Fellowships to a select group of students each year. For further information on this program, see: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=6201&org=NSF.

There are numerous other sources of fellowships and grants that can be found with some search time online. For example, we suggest that you check out *Foundation Grants to Individuals* website at: http://gtionline.fdncenter.org/ and the Smart Student Guide to Financial Aid website: http://www.finaid.org/ Also, the University of California–Santa Cruz maintains a website with an extensive number of links to other potential sources of funding. Their site is at: http://www2.ucsc.edu/eop/gip/funding.htm. The National Institutes of Health maintains a similar website: http://www.training.nih.gov/careers/careercenter/fellow.html.

When Should You Start Investigating Graduate Schools?

Applications for graduate school are typically due sometime between December and April (students then begin graduate work the following August or September). As such, your investigation of potential graduate schools should begin no later than early in the fall of your senior year. It is at this time that you want to contact potential graduate supervising professors and arrange visits (for details on how to do this, see below). You should also make arrangements to take the Graduate Record Exam (described below) in the fall or very early in the new year.

Strategies for Finding a Graduate School and a Graduate Supervisor

In graduate school, you do research under the supervision of usually one professor. Two or more other professors will sit on your "graduate committee" and will usually provide advice and help as well. It is sometimes said that your choice of a supervising professor is second in importance only to your choice of a mate. True enough. There are numerous horror stories of supervisors so bad that they caused their students to take several extra years to finish their degrees or simply drove them out of graduate school altogether in utter frustration. You must find a supervisor that is knowledgeable, supportive, and reasonably easy to work with. You want someone that wants to see you succeed and is obviously willing to help you do so. You want to avoid someone that takes a hands-off "sink or swim" attitude to their graduate students because they really don't care about you all that much. You also want to avoid a potential supervisor that is too busy to provide you with enough help even if they want to do so.

While your choice of a supervising professor is most important, it is also important that the department in which that professor is based is also of good quality. All else being equal, it is desirable to be in a department where there are multiple professors and graduate students working in your general area of interest. It can, for example, get mighty lonely and boring if you are, say, the only field-oriented person in a department where everyone else is doing molecular or cellular

biology. It is also wise to choose a department that has numerous interesting graduate courses for you to take.

Again, though, we must stress that your choice of a research supervisor is most critical. Some students assume that if they just can get into a highly regarded school like Harvard or Berkeley or Stanford, they will be successful no matter what because these schools have such a good reputation. However, these schools, like all others have their share of faculty who are exceptionally bad graduate supervisors. You are far more likely to be successful with a supportive, attentive, concerned supervisor at a mid-level school than an unengaged, unhelpful, egomaniac at a top-tier school.

Ok, so how do you find a good supervising professor (and school)?

Finding a graduate supervisor/university when you have specific interests in Biology

Finding a good graduate supervisor and school is easiest when you know what *specific* area(s) of Biology are of interest to you. For example, you may be generally interested in cell biology but are especially intrigued by the, say, phenomenon of apoptosis (programmed cell death), or cell-to-cell signaling, or tumor biology. Or you may be generally interested in mammals but specifically interested in, say, bat biology, or in mammalian conservation. In this situation, it is relatively easy to identify those individuals that are actively conducting research (and supervising graduate students) in your specific area(s) of interest. For example, while many hundreds of professors study the biology of mammals, probably fewer than 15 are actively working on bats. More people are working in the area of mammalian conservation but the number is still manageable.

So how do you find out who these people are? We suggest several strategies:

1. Start by talking to TU faculty members who work in your general area of interest. Tell them your specific area(s) of interest and ask them to help you identify potential graduate supervisors in that area. If a faculty member is active in research themselves, they will know the major "players" in field.

2. Get to the library or get online and find out who is publishing papers in your area of interest. For example, you can access the "Web of Science" database through Cook Library and do a search for papers published in the last year on "apoptosis." Acquire 10-15 or more of the papers that, based on titles and abstracts, seem most intriguing to you. Using information in the paper, or an on-line search, find out where the authors are based, i.e., their school and department*. You can then go to departmental websites and try to find out more information about those individuals and their interests**. You can also discuss the papers, their authors, and their schools/departments with TU faculty members who may very well know these individuals personally. By the way, do not hesitate to contact professors outside the U.S., especially in Canada. Many foreign schools have special scholarships for students from other countries.

*Note that rather than just having a "Department of Biological Sciences," many larger universities have more specialized departments such as Departments of Molecular Biology, Microbiology, Neuroscience, Health Sciences, Population Biology and Ecology, etc.

**Note that the "quality" of faculty websites varies quite a bit. While many active, wonderful professors take the time to maintain interesting, informative websites, some do not. Some professors are just too busy doing things like teaching up-to-date, fascinating classes and helping their graduate students with research to maintain a fancy website. So don't let a simple website deter you. If the professor is actively doing research in your area of interest, consider them regardless of the state of their website.

3. As described in detail below, once you have identified a few researchers in the field, you will be contacting them to inquire about doing graduate work under their supervision. You can ask *them* to recommend other potential graduate supervisors and schools.

Finding a graduate supervisor/university when you have <u>not</u> narrowed down specific interests

Now, what if you love Biology but are just not able to narrow down your area of interest very far? What if, for example, you are generally interested in, say, plant physiology, but you are not sure what aspect of this sub-discipline you would like to study. You might again start by talking to the TU faculty member who teaches plant physiology. Ask that person about current "hot topics" in the area of plant physiology, i.e., major areas of research. Ask the faculty member what institutions are renowned for turning out strong, successful graduate students in plant physiology. You may learn, for example, that the University of California – Davis, Texas A & M University, and the University of Calgary in Canada have particularly strong and well-respected programs. Get online, look at the programs, and see what specific topics the faculty are researching. If the research topics in one or more laboratories look intriguing, make some inquiries (see below). Ask the people you contact to recommend other potential supervisors and graduate programs.

Be prepared to relocate

Ideally, you should be willing to go to the best graduate program available given the quality of the potential supervisor, the department, and the financial aid available. The better the program, the better your chances for a long and successful career! You should be prepared to discover that the best program is located in New York, New Mexico, Nova Scotia, or some other seemingly far off place!

Having said that, we realize that in some instances, individuals may be not be able to travel far and wide for graduate school. For example, your "significant other" may get a great job or position in say, the D.C. area, forcing you to look in that general area for graduate schools. In this situation, you should obtain a list of colleges and universities within, say, a 100-200 mile radius (easily found with a Google search using keyword combinations such as "Colleges and Universities Virginia), then locate the home pages for these institutions. Click on "Academics" to see if they have a Department of Biological Sciences (or Molecular Biology or Zoology) and, if so, whether they have a graduate program. If they do, find a list of faculty, their research interests, and their publications. If there are faculty doing research of interest to you, with good track records (an active laboratory, recent publications including publications with graduate students), contact them, as described in the next section. Avoid "deadwood" professors that have not published in the last 3-4 years. Chances are good that their ideas and abilities will be out-of-date.

Contacting a Graduate School and Potential Supervisor

Once you have identified several potential graduate programs and supervisors, it is time to make two contacts. First, you need to request application materials and a graduate catalog. Most departmental websites will have instructions on whom to contact. Otherwise, there will be a link on their homepage for something like the "Graduate School," the "College of Graduate Studies," or the "Graduate Admissions Office," which will provide instructions as to how to get application materials.

NOTE: At some schools, you must obtain and complete *two* different applications, one that goes to the general "Graduate School" or "College of Graduate Studies" or perhaps the general admissions office and another that goes to the department to which you are applying. At other schools, students have to complete just one application. Check carefully to make sure that you have all required applications and an understanding of where they should be sent.

Second, you need to contact the professors with whom you would be interested in working. It is best to do this by e-mail. The body message should be in the form of a 'cover letter." An example cover letter appears in the Appendix. As you can see from that example, the purposes of the cover letter are to introduce yourself, express an interest in working under this person's supervision, tell them something about your *specific* research interests, and ask them to get back to you.

The best professors get dozens or more e-mails each year from prospective graduate students. However, many of them are boring "form letters" with no real content. To be noticed, your letter should be informative and personalized. As regards the latter, you should indicate to the professor why you are contacting *them* in particular. Make sure that they know that you are familiar with their research and that your interests are similar to their interests. Indicate that you have read certain papers of theirs (which you should have done) and mention the findings that you find intriguing. Sell yourself; i.e., give the impression that you are a highly motivated, well-organized, hard-working student who will not only be productive in research but will add vim and vigor to their research team. Make sure you spell the professor's name and the name(s) of their study organism correctly! In fact, make sure the entire letter is completely free of spelling errors, typos, and grammatical no-no's. It would be wise to have a trusted, helpful faculty member at TU read and comment on your letter before it goes out.

You should include two important attachments with your e-mailed cover letter. First, attach your *curriculum vita*, which is a scientific resume (see the Appendix for instructions on how to put a CV together). Second, attach a list of science and math courses that you have had and the grades that you obtained (for an example, see the Appendix).

Responses to your e-mail will vary greatly. Some professors will not respond at all. It is most likely that they are not taking on new students and are too busy to send you a brief message indicating this. This is rather rude on their part, to be sure, but don't take it personally. Other professors will write back and tell you, in some way, that they are not interested. Most often professors will say something like: "I am not taking on new students at this time." Assume that this is true and don't take it personally. Professors really do have many legitimate reasons for not taking

on more students in any particular year. Each professor has a "carrying capacity" and can handle only so many active graduate students at a time.

Finally, some professors will express an interest in you and want to pursue things further. Make sure that *you* respond promptly with an e-mail or a phone call. If things look good, think about a visit (see below).

What Graduate Schools Consider When Reviewing Applications

Graduate programs take into consideration several factors when deciding whether to accept you and provide you with financial support. These are:

1. What undergraduate courses you have taken

   Obviously graduate schools are going to want you to have an appropriate set of Biology courses. For example, if you are interested in Virology, then it would be wise to have courses such as Virology (of course!), Cell Biology, Molecular Biology, and Immunology on your transcript. That you took Ornithology as well will not impress them much (even if you did get an A). In addition, top graduate schools, especially those with Ph.D. programs, require two semesters of organic chemistry, two semesters of physics, and one semester of calculus. Some programs that only offer an M.S. degree will admit students to study in some areas (e.g., Ecology, Zoology, Animal Behavior, Conservation) if they have less then four semesters of chemistry and two semesters of physics…but don't count on it. If you think you might go to graduate school, you need to complete a full year of organic chemistry and physics if at all possible, along with a semester of calculus.

2. Your academic performance (courses grades and GPA)

   Performance in undergraduate coursework will be judged by your GPA. Different schools will examine either your overall GPA, your GPA in science and math courses, your GPA in you junior and senior year, and/or grades in courses that are critical to your proposed areas of study and research. In some cases, schools and potential supervisors will look at your grades in specific courses. For example, say that you are applying to do graduate research in molecular genetics. Your GPA is not spectacularly high; you are generally a B to B+ student. However, you did get A's in Genetics, Molecular Biology, and Introduction to BioInformatics. This should help you considerably.

3. Scores on the Graduate Record Exam (GRE)

   Almost all schools will require scores from the *GRE General Test.* This test measures basic critical thinking, analytical writing, verbal reasoning, and quantitative reasoning skills that all university graduates should have, regardless of their major (further details on this test appear below).

   Some schools also require students to take the *GRE Biology Subject Area Test* (also described in more detail below). NOTE: One might think that a graduate program in Biology would be much more concerned about an applicant's *Biology* knowledge and thus would weigh scores on the

Biology subject area test more heavily than scores on the General Test. In fact, the opposite is true. Many schools do not even require the Biology subject area test because scores on the three different parts of the test (see below) just reflect what elective courses a student took as an undergrad and do not predict success in graduate school. In contrast, a student's ability to think critically, write, reason, and do math, measured by the General Test, does tend to predict success in graduate school.

4. Letters of recommendation

You should be able to provide three letters from professors and/or undergraduate internship and research supervisors who know you well and, preferably, can speak to your capabilities and your motivation to attend graduate school and do research. Further advice on letters of recommendation is found above in the section: *Some Practical Advice for Students Seeking Jobs: Letters of Recommendation*.

5. Research Experience

Research, while often exciting and rewarding, can be a tedious, frustrating, painstaking endeavor. All else being equal, graduate programs and supervisors will give the edge to applicants that have learned this lesson and so know what they are getting themselves into! Research also requires a variety of skills, many of which are not taught in regular courses. Students who have some "pre-training" for graduate research are often preferred.

6. A graduate professor's desire to take you on as a student

At most graduate schools, there are always more applicants than positions available. Decisions as to which applicants get admitted, and which of those individuals get assistantships are made by the department's Graduate Committee. This committee takes into account coursework, GPA, GRE scores, letters of recommendation, and experience as described above, but they also take into account how strongly a faculty member wants a student to come and join their research team. If a professor really wants you to come join them, they will make this known to the Graduate Committee verbally or by letter. This can be a huge boost to your chances of being admitted. Indeed, strong support from one of the department's faculty members can, in fact, override some shortcomings that you might have. For example, your GPA and/or GRE scores may not be spectacular but if a professor still pushes for you to get into the program because they are impressed with your hands-on experience and your motivation to succeed, you will be considered seriously. This is one of many reasons why it is so essential that you make contact with potential supervising professors and, if possible, visit schools in person (see more on visits and interviews below).

The Graduate Record Exam

The GRE General Test

Almost all U.S. graduate schools require the Graduate Record Exam-General Test as this test does, to a significant extent, predict success in graduate school. A detailed description of the General Test can be found at the website of the company that created this test, the Educational Testing Service: http://www.ets.org. Briefly, the General Test has three sections: 1) a*nalytical writing*, which

measures a student's ability to articulate complex ideas clearly and effectively in writing, examine claims and accompanying evidence, support ideas with relevant reasons and examples, sustain a well-focused, coherent discussion, and write standard English properly; 2) *verbal reasoning*, which measures ability to analyze and evaluate written material and synthesize information obtained from it, analyze relationships among component parts of sentences, recognize relationships between words and concepts; and, finally 3) q*uantitative reasoning*, which measures ability to understand basic concepts of arithmetic, algebra, geometry, and data analysis, reason quantitatively, and solve mathematical problems, including word problems. Much more information on the format of the test can be found at the website above.

Take the GRE General Test very seriously. Relatively low scores in any one of the three test areas can be the "kiss of death" when it comes to getting into a good graduate school. Prepare extensively for the test; don't take it "cold." A wise strategy is to devote some of your time in the summer after your junior year and the early fall of you senior year preparing for the exam, and then to take it shortly after that (by early January). Your motivation to work on the exam during the summer will be much greater if you obtain and take a practice test during your junior year. This will show you what you are up against and how much you don't know, or have forgotten.

Most bookstores have preparation guides for the GRE which include practice tests (such guides may also be available on-line). You can also take one of the GRE preparation courses offered by companies like Kaplan. These courses are routinely advertised on the bulletin boards in Smith Hall.

If you do poorly on the exam, you can take it again. Repeating the test is fairly common. However, be aware when the Educational Testing Service sends your scores to the graduate schools to which you are applying, they send scores from *all* of your attempts at the test. Some graduate schools consider only your most recent test scores but some average scores. Be as ready as you can the first time you take the test.

If you take the test and know right away that you did very poorly, you may be able to have your scores "canceled" altogether – and they will never be reported. Check the ETS website for information on the cancellation procedure.

The Biology Subject Area Test

The Biology GRE test is described in detail at the ETS website given above. Briefly, the test contains roughly 200 multiple-choice questions organized about equally into three major areas: 1) Cellular and Molecular Biology; 2) Organismal Biology; and 3) Ecology and Evolution. In addition to the total combined score, a subscore in each of these subfield areas is reported by ETS to graduate schools. Much more detail on what the test covers in each of these three areas is found at the ETS website.

Graduate School Interviews

Once you have narrowed your list of potential graduate programs and graduate supervisors down to around two to four schools or so, if at all possible you should try to arrange a visit to each school or at least your top two schools. This will give you a chance to meet your potential research supervisor and get a good feel for whether you would be comfortable working with this person.

You can also meet the professor's current graduate students and other faculty members, and get a tour of the facilities available. (Note: You might consider visiting *before* you actually apply to a school, assuming there is enough time to do so before the application deadline. This can save you money if you decide not to apply to a school based on your visit. Graduate schools typically charge you $40-70 just to process your application).

To plan an on-site visit, you should first contact the potential supervising professor, indicate that you would like to visit, and ask when this would be convenient for them. You can also provide a list of various dates that would be convenient for you (try to be as flexible as possible). In planning a visit, make sure you don't overstay your welcome. Plan initially to be on campus one full day coming in the night before and/or leaving the next morning. You may be invited to stay longer by the professor, but wait for the invitation.

Don't hesitate to ask your potential supervisor whether there are funds available to bring in prospective graduate students. Some programs routinely cover all or at least part of the travel costs for top graduate student prospects. Even if no funds are available, we cannot stress enough that it would still be worth spending some of your own money (or your parents' money) to visit different schools. Finding the right graduate program and supervisor is just that important and there is just no substitute for an on-site visit in helping you make an informed decision.

Your potential supervising professor will likely work out an itinerary for your visit in advance. You should request that itinerary several days before your trip so you can prepare (at least try to get the names of people that you will likely meet). You will probably have a long meeting with your potential supervising professor to start with. He or she will have a number of questions for you. In part, they will be trying to gauge your level of interest, enthusiasm, and motivation. They will try to get a sense as to whether you will be a good "fit" personality-wise with them and their other students. They will also try to get a feel for your level of preparedness. Without question, by the time that you arrive, you should have read your potential supervisor's most recent publications. Definitely ask questions about this work and the current work in the laboratory. Professors love inquisitive, curious students and tend to avoid "wallflowers."

You should come with a lengthy list of other questions to ask your potential supervisor. Perhaps most important will be a discussion of what *you* might do for your research. You may wish to bring up some subjects or projects that interest you. You should also ask the professor about potential research projects that they have in mind. Absolutely ask the professor about the potential "publishability" of different projects including both projects that you suggest and those that your potential supervisor suggests. Don't hesitate to ask something like: "Is this project likely publishable, and if so, in what journals?" As we have said before, your success and potential as a scientist is measured by the contributions you make to knowledge in the form of publications. Publications are your ticket to a great career. This is why you must choose a professor that has published recently and regularly. Such professors will know what research will and will not be publishable in respected scientific journals.

Ask the professor to talk about the last several graduate students that completed their degrees under his or her supervision. If you are applying to do an M.S., ask specifically about Master's students. Try to find out if these students have published or have submitted papers. Ask where the students are now and what they are doing. If most students have gone on to Ph.D. programs, post-doctoral

fellowships, or jobs, that is a good sign. If most students are working at Wal-Mart or Starbucks or some such place, that is not so good.

You should also ask about how your research might be funded. Does the professor have funds from a grant that will support your research? Does the department or university provide small grants to graduate students to support research? Are undergraduate students available to serve as research assistants?

You should ask for more details about assistantships. If you are likely to get a TA, ask what classes you are likely to help teach. Also, find out how long assistantships last. Some schools rigidly provide M.S. students with two years of support and Ph.D. students with four years of support. Often students legitimately need an extra semester or two of support to complete their degrees. Is an extra semester or two of support available if needed?

During your interview, you will also meet with other faculty, especially those that have interests related to your own interests. Before you arrive, do some background work on these individuals. Get online, find their websites, memorize their areas of interest, and get and read one of their recent publications. Come armed with a few specific questions to ask about their research. This sort of initiative and interest (not to mention the ego boost for the professors) will *really* impress people making it more likely that you will get accepted into the program and get an assistantship. This is especially true if these individuals sit on the graduate committee.

Speaking of assistantships, you are also likely to meet with the person(s) in charge of supervising graduate teaching assistants, i.e., the Graduate Program Director. This is a crucial interview for you. They will try to get a sense of whether you would be an effective TA. Will you be an enthusiastic, motivated, confident instructor that will take your teaching responsibilities seriously?

Finally, one thing that should be on your itinerary is a meeting with your potential supervisor's current graduate students - *alone*. If this is not on the itinerary, ask that it be added. This meeting is crucial. In this meeting, ask the current graduate students tactfully but very directly what it is like to work with the supervising professor. Assure them that anything that they relate will be held in strict confidence (and make sure you keep it in confidence). Include the following among the things you ask current
students:

- Ask whether the students feel that the professor has enough time to help them. If students routinely have to wait a week or more to see a professor and then get a harried 10 minutes, that's a sign of trouble.
- Ask the students about the professor's policy and reputation for publishing with students. Does the professor have a reputation for generously including on papers the names of all students who contribute to the research? Watch out for publishing "horror stories" such as professors putting their names first on research done primarily by students.
- Ask if the professor is consistent in their advice to students. Some professors are so scatter-brained or manic that they will tell students to do their research one way and turn around several months later and criticize them for doing it that way, not remembering that this was their advice in the first place.

- Ask the students what *they* know about students who recently worked with the professor. Do they mention students that the professor did not, especially students that dropped out or ended up working for Toys-R-Us? If one or more students washed out of the program, ask why, to get a sense of whether this was the student's fault, the professor's fault, or some of both. If there are *numerous* accounts of students quitting before finishing, or finishing but not publishing, that is a big danger sign. On the other hand, if current students go on and on about the great publications and good positions of recent students, that's a very good sign.

- Ask the students about what it is like to be a TA in the department. Are students required to work more than their contracts say they are supposed to (usually 20 hours per week)? Are students regularly thrown into classes with little training or help? Are they asked to teach classes for which they have no background?

- Ask what the rental situation is like in the local area and whether assistantships pay enough money to pay rent and buy food. Can students only afford rent in the more crime-ridden parts of town?

In listening to the current students, try to get a feel for whether there is a cooperative or competitive relationship among the graduate students. Try also to get a feel for whether they generally like and respect their advisor as a mentor and as a scientist. If you sense much disdain for the professor, that is worrisome.

All the usual other advice for job interviews applies to graduate school interviews as well. Dress nicely but don't be overdressed; biologists are generally pretty informal. You do not need to wear a coat and tie or a dress and heels. On the other hand, don't dress too far down. For example, avoid faded, ratty looking jeans, really short shorts, flip-flops, etc. This will suggest a lack of maturity, respect, and seriousness. If you are a field-oriented person, be ready to be taken into the field, e.g., to see potential research sites (have available old jeans, hiking boots, etc.). Also have clothes for going out at night with current graduate students.

Don't chew gum and don't smoke without permission. Try to avoid colloquial, immature speech (especially overuse of words such as "like" and "awesome"). You may be asked about certain classes and professors that you had a Towson. Feel free to speak highly of positive experiences but avoid demeaning or belittling classes and professors that you felt were of low quality. We are not suggesting this to protect our egos. The point is that if you are willing to bad-mouth your undergrad professors and classes, it is assumed that you will do the same wherever you go and this will not be welcome.

After you return, you should send a thank you e-mail to both the supervising professor and the graduate students who housed and fed you.

Choosing a School and Potential Supervisor – A Summary of What to Consider

If things go well, more than one graduate program will be interested in having you. In making your decision, weigh the following factors, in approximate order of importance.

1. Am I being offered a tuition waiver and assistantship and is it enough to live on?
2. Does the evidence suggest that my potential supervisor will be pleasant to work with, supportive of my research and other goals, and have time enough to provide help and advice when I need it?
3. Does it appear that I will be able to do research that is both interesting to me and readily publishable?
4. Does the school have the facilities and equipment that I need to conduct my research?
5. Is there funding available to support my research?
6. Will I enjoy interacting with other people in my professor's lab including graduate students, post-docs, and technicians?
7. Are there a number of interesting, useful graduate courses being offered?
8. Would I like living in the local area?

Recommended Reading for Students Thinking Seriously about Graduate School

We highly recommend, the following excellent, tell-it-like-it-is guide to getting into graduate school and succeeding in graduate school, which was written by a biologist.

Peters, R.L. 1997. *Getting What You Came For – The Smart Student's Guide to Earning a Master's or Ph.D.* (Revised edition). Farrar, Straus and Giroux. ISBN: 0374524777

Other guides to graduate school that may be helpful include:

Frank, Fredrick and Karl Stein. 2004. *Playing the Game : The Streetsmart Guide to Graduate School*. iUniverse, Inc. ISBN: 0595304869

Jerrard, Richard. 1998. *The Grad School Handbook.* Perigee Trade. ISBN: 0399524169

Mumby, Dave G. 1997. *Graduate School: Winning Strategies for Getting in With or Without Excellent Grades.* Proto Press Publications. ISBN: 0968217346

Kaplan Co. 2003. *Get Into Graduate School: a Strategic Approach*. Kaplan. ISBN: 0743240952

Finally, with a bit of searching online, you will find numerous other guides to getting into, and succeeding in, graduate school, some specifically designed for Biology majors.

APPENDIX

Sample cover letter to send to prospective graduate supervisor

30 February 2010

Dr. Russell N. Winges
Department of Biology
Minnesota State University
Frozen Lakes, MN 55332

Dear Dr. Winges,

I would like to introduce myself and inquire about applying to do graduate work under your supervision, starting in the fall of 2008.

I am currently an undergraduate at Towson University, near Baltimore, and will be graduating in May, 2008, with a B.S. in Biology. I have attached my CV and a list of science and math courses that I have taken, along with grades received. My overall GPA is 3.65, my GPA in Biology courses is 3.58, and my GPA in all science and math courses is 3.49. My scores on the GRE General Test were 550 on the Verbal section (72% below), 700 on the Quantitative section (68% below) and 5.5 on the Analytical Writing section (86% below).

I have recently developed a strong interest in the reproductive behavior and ecology of birds. I would like to pursue this interest in graduate school. I am familiar with your recent work on extra-pair mating and polygamy in different species of blackbirds and think that our interests match up well. I am particularly interested in studying the evolution of mating strategies in birds and am intrigued by the application of techniques from molecular biology in this research. However, I am very willing to become involved in research on other aspects of avian biology.

I have had some experience conducting biological research. This past summer I worked as an assistant to Dr. Earl J. Waggendorn on a project investigating extra-pair mating in Baltimore Orioles. During the course of this research I learned a number of field techniques including mist-netting, banding, measuring adult birds and taking blood samples from adults and nestlings. I also learned DNA extraction and PCR analysis in the laboratory. Before that, I worked with Dr. Forrest Bufophile on a project that looked at habitat use in wood turtles.

I would appreciate knowing whether you are taking new students for the fall of 2008. If so, I would also like to know more about the application process and about opportunities for financial support.

Finally, I would appreciate any suggestions for other potential graduate supervisors and programs that I might contact, especially if you are not taking on new students.

Thank you for your time and consideration.

Sincerely,

Maria Q. Student
Mstude1@towson.edu
410-555-9876

Mailing address:
203 Heartbreak Hill Road
Baltimore, Md. 21228

Sample Curriculum Vita (CV)

A curriculum vita or "CV" is a lengthy scientific resume that is frequently used primarily when applying for graduate school and jobs in science and technology. A sample CV is provided below. In general, a CV should contain the following information:

- Your contact information
- Your post-secondary educational history, including your GPA
- Scholarships, fellowships, honors, and awards
- Employment history
- Research/technical experience
- Research funding
- Relevant extra-curricular activities
- Scientific publications on which you are an author
- Papers presented at scientific conferences
- Membership in professional societies
- Teaching experience, if any
- References with contact information

Maria Q. Student

203 Heartbreak Hill Road 410-555-9876
Baltimore, MD 21228 Mstude1@towson.edu

Education

Program	B.S. Biology
Date degree expected	5/2008
Institution	Towson University

Overall GPA: 3.65 GPA in science/math courses: 3.49 GPA in biology courses: 3.58

Scholarships, Fellowships, Honors, and Awards

Honorable Mention, Barnard Rubble Award; Best Undergraduate Researcher
Towson University – Department of Biological Sciences, 2007

Elected to Beta Beta Beta Biological Honor Society, 2007

Alfred E. Newman Scholarship for Outstanding Transfer Student
Towson University – Department of Biological Sciences, 2006

Lions Clubs of Maryland University Scholarship, 2004

Employment

Position	Animal Caretaker, Veterinary Technician
Dates	Mar. 2004-present
Location	Cat Hospital at Towson

Position	Sales Clerk
Dates	Sept. 2000-Apr. 2004
Location	Eddie Bauer - Towson MD

Research Experience

Position	Participant, NSF Research Experience for Undergraduates Program, Indiana University
Dates	Summer 2007
Project	Effect of breeding synchrony on extra-pair mating in Baltimore Orioles
Supervisor	Dr. Earl J. Waggedorn
Duties/skills	Nest-finding, behavioral observation, mist-netting, banding, blood sampling, DNA extraction, PCR analysis

Position	Undergraduate Research Assistant, Towson University
Dates	October 2006-May 2007
Project	Description of home ranges and habitat use of wood turtles in fall and spring
Supervisor	Dr. Forrest Bufophile
Duties/skills	Radio telemetry, territory mapping

Research Funding

Undergraduate Research Grant, Fisher College of Science and Mathematics, Fall 2006, $500

Sigma-Xi Scientific Research Society Grant-in-Aid-of- Research, Sept 2006, $650

Presentations

Jimenez, M.Q. and F. Bufophile. "Effect of temperature on daily movement patterns in wood turtles". Herpetological Association meeting, Laramie, WY, Aug 2007.

Publications

Bufophile, F., Jimenez, M.Q., and Smart, M. 2007. Home range size of wood turtles in central Maryland. *Southeastern Naturalist* 45: 908-911.

Membership in Professional Societies

Society for the Study of Amphibians and Reptiles, 2006 to present

Teaching Experience

Undergraduate Teaching Assistant, Comparative Animal Physiology, Towson University, Fall 2006
Duties: Assist in setting up laboratories, helping students during experiments, some mini-lectures

Extra-curricular Activities

Secretary, Beta Beta Beta Biological Honor Society 2007-present
Volunteer instructor, K-6 grades, Irwin Nature Center, Baltimore, 2006-present
Initiate Advisor of Phi Sigma Pi National Honor Society, 2005

References

Dr. Earl J. Waggedorn	Dr. Forrest Bufophile	Dr. Chuck Darwin
Dept, of Biology	Dept. of Biological Sciences	Dept. of Biological Sciences
Indiana University	Towson University	Towson University
Bloomington, IN 33445	Towson, MD 21252	Towson, MD 21252
346-555-2373	410-555-4389	410-555-4388
ejwaggedorn@iu.edu	fbufo@towson.edu	cdarwin@towson.edu

Sample listing of courses and grades to send to prospective graduate supervisor

SCIENCE AND MATH COURSES AND GRADES – Maria Q. Student

BIOLOGY

BIOL 201: Introduction to Cellular Biology and Genetics	A-
BIOL 202: Introduction to Ecology, Evolution and Behavior	A-
BIOL 205: General Botany	A
BIOL 207: General Zoology	A-
BIOL 325 Animal Physiology	B
BIOL 347: Marine Biology	B+
BIOL 351: Field and Systematic Vertebrate Zoology	A
BIOL 353: Invertebrate Zoology	A-
BIOL 381: Biological Literature	A
BIOL 402: General Ecology	B-
BIOL 406: Limnology	B
BIOL 408: Cell Biology	A
BIOL 413: Evolution	A
BIOL 456: Ornithology	A
BIOL 467: Herpetology	currently enrolled
BIOL 469: Comparative Animal Physiology	B
BIOL 486: Biology Majors Seminar	currently enrolled
BIOL 491: Independent Research	A

CHEMISTRY

CHEM 101: General Chemistry I	C+
CHEM 102: General Chemistry II	B
CHEM 331: Organic Chemistry I	B-
CHEM 332: Organic Chemistry II	B

PHYSICS

PHYS 211: General Physics I	B
PHYS 212: General Physics II	currently enrolled

MATHEMATICS AND STATISTICS

MATH 273: Calculus I	B
PSYC 212: Behavioral Statistics	A-