How to go to Graduate School in Biology

Contents:

and* THE ADVICE COLUMNS *– advice from faculty, graduates, and current students on applying to grad school.

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HOW TO GO TO GRADUATE SCHOOL IN BIOLOGY

Most professional jobs in the biological sciences today require an advanced degree beyond the baccalaureate, either a Master of Science (M.S.) or Doctor of Philosophy (Ph.D.). The PhD is required for virtually all positions of independence in research, weather they are in a university, a medical school, industry, or a private government research laboratory. This is because the Ph.D. requires the completion and defense of a research project, usually of publishable quality, and therefore provides evidence of the ability of the individual to carry out independent research. The Ph.D. usually takes four or five years of study. The M.S. degree, which usually takes 1 to 2 years and is sometimes taken en route to the PhD, does open up jobs at a higher level than the A.B. or Sc.B., but not ones of scientific independence. The discussion in this brochure focuses on the Ph.D. (in biological sciences), and addresses many issues that concern students considering this path.

Most graduate programs offer training in fairly specific areas of biology, such as biochemistry, physiology, ecology, etc., although a few offer programs in general biology. Students considering graduate school must therefore identify a specialty interest or focus in a particular area of biology. Finding this focus is an exciting challenge for the undergraduate. It is important to realize that there is no single experience that can provide this information. However, a number of experiences should be pursued that will contribute information cumulatively.

I. UNDERGRADUATE PREPARATION

Planning a curriculum

Include courses for adequate background. The required courses for the AB in biology at Brown, plus the recommended year of physics and year of organic chemistry, provide sufficient preparation for most graduate programs in the biological sciences, as do the requirements for the ScB in biology. Students concentrating in one of the other sciences will often also be admitted, particularly if they have some biology courses. Requirements will vary among the different fields in biology, but many graduate programs will accept the talented science student who lacks specific preparation which can be made up during the first year.

Include biology courses that ensure adequate breadth and depth. A broad knowledge of S biology will not only be valuable in forming an informed perspective later on, but will also aid in the choice of biological area to pursue. Pursuit of one area to substantial depth will provide the exposure to what biology is like, without which the decision to go to graduate school is not an informed one.

Seek opportunities for individual research. Many agree that students should determine above all, if they love doing research, and would enjoy a career doing their own research. Ways of finding out include volunteering in labs, taking independent research courses, and seeking summer opportunities for research. A two semester senior research project leading to an honors thesis provides particularly good exposure to research for the Brown undergraduate.

Seek opportunities for teaching. Since teaching is an important component of academic positions, and required of graduate students, it would be helpful to get some experience. One way of doing this is to serve as an undergraduate teaching assistant. Many of these positions require some lecturing to groups, one-on-one instruction, running discussion and review sessions, preparing quizzes, and grading assignments or examinations. Other teaching opportunities may be found in summer programs.

If not sure, don't go yet. Time off between finishing college and beginning graduate school is fine if it is spent in a useful way. One option is to get a job in a research lab or related area for one or more years before applying. This period may serve as a serious occupational test, as well as provide time for specifying interests or strengthening commitment.

II. TYPES OF PROGRAMS AND HOW TO CHOOSE ONE

The major problem in choosing a program is that they come in all sizes and shapes, and there are too many to investigate them all. *Peterson's Guide to Graduate Programs in the Biological and Agricultural Sciences* contains over 2200 pages with entries from over 500 institutions, divided into over 70 subspecialties such as bacteriology, ecology, or plant sciences.

A. TYPES OF PROGRAMS

1. University vs. Medical School. Ph.D. programs in the biological sciences can be found not only on "Arts and Sciences" university campuses, but also in medical schools. Brown is unusual in having its biology and basic medical science units fully integrated. Virtually all other medical schools are separate entities, sometimes on the same campus as the parent university (e.g. Case Western), sometimes in the same city but some distance away (e.g., Yale, Johns Hopkins), and sometimes more than 100 miles away (e.g., Cornell).

Medical school programs are generally grouped around the basic medical sciences-anatomy, biochemistry, microbiology, etc., and do not include subspecialties distant from human biology, e.g., botany or ecology. Until recently they tended to be administered through the individual departments of the medical school. However, the recent rapid developments in biology have blurred the lines between sub disciplines, and many medical schools are moving to admitting students to broader “umbrella” programs in biomedical science, with choice of a specialization deferred until the second year.

Conversely, most university graduate programs until recently were in broader departments of biology or biological sciences. The rapid expansion of biological knowledge has led to subdivisions into major areas (and sometimes separate departments) such as molecular biology, neural sciences, etc.

The atmosphere in most medical schools is quite different from that on university campuses. The opportunities to link one’s studies to clinical medicine abound in the former, but the general cultural opportunities of an arts and sciences campus are lacking. (However, many graduate students at the latter will tell you they don’t have time for many cultural activities anyway, and that their lives are very centered in their departments.)

2. Broad vs. narrow. There remains a wide spectrum of how broad a subject a particular program covers. If you know that you want to be an immunologist, you may prefer to be in an immunology program with perhaps fifteen faculty to choose from to guide you in an immunological project. If you don’t know whether you want to do immunology, molecular genetics, or cell biology, you may be better off choosing a program in molecular and cell biology where you can specialize in any of these topics. The trade off is that there will probably be only a handful of potential thesis advisors in each subspecialty.

B. HOW TO CHOOSE A PROGRAM

There are various ways of approaching the task of choosing the graduate schools to which you will apply. The following are some guidelines.

1. Think about what aspects of the biological sciences really fascinate you (Professor Rothman’s criterion is: which are the ones that you think about even in the shower or bathtub. If none, you may not be cut out to be a biologist.) If you have many interests, you are probably better off in a broad program which permits choice after admission.

2. Browse in the Peterson’s Guide to get the flavor of different kinds of programs. With a specialty interest and some geographic choices, a student can consult Peterson’s Guide for many possible programs. Peterson’s is a compendium, published annually, that includes hundreds of graduate program summaries. It lists each program’s faculty, along with their individual research topics (briefly). For each program, it also gives general information about programs of study, research facilities, financial aid and costs, student life and application requirements. Its contents are organized by type of program, e.g., Anatomy, Biochemistry, Physiology, etc., and it is indexed by university name.

3. Talk to faculty members, particularly ones with whom you are doing research, or ones in the areas of your interest. Most faculty have many contacts in other schools, visit them from time to time, and can give you informed advice.

4. Don’t hesitate to take personal factors into consideration. There are many excellent graduate programs all over the country. If you want to be with your significant other who is settled in San Francisco, don’t apply on the East Coast. If you have season tickets to the Metropolitan Opera, look at the New York schools first.

5. After settling on a number of interesting programs, formal bulletins should be requested from individual schools or check the website. Program bulletins and websites give detailed information on faculty research programs, along with recent publications. With this information, the field of choices should begin to narrow.

6. Plan to visit all of the schools to which you are applying. A one-to-two day visit often provides the crucial information for a decision. A personal visit can be an important source of information and impressions. It can reveal a sense of the school and program atmosphere; provide a view of facilities; and offer a chance to meet and chat with individual faculty members (potential mentors!) as well as current graduate students. To gain the most from a visit, it is wise to go while school is in session (not during vacations). It is also worth looking up some research papers: showing awareness of particular faculty members and their work will enhance the visit. Besides science, other issues the student may address include: the realistic range of opportunities available; expected timetables for completion of different phases of the program; adequacy of supervision/interaction; possibilities for switching labs or projects, if necessary; rate of student attrition; post-graduate fates; integration of graduate students with the rest of the university community;

variety of graduate course offerings; housing arrangements and costs; and of course, general student happiness and satisfaction with the program. It is important to discuss these issues both with faculty members and with current graduate students.

III. TIMETABLES AND APPLICATION

From the point of deciding to go to graduate school, there are various time factors to be considered. One is the delay between requesting formal bulletins, and actually receiving them! Another is time for communicating with potential faculty sponsors, and for visiting different schools. The Graduate Record Examination is required for many applications: these must be taken and scores received, in time for application deadlines. The GREs are administered six times a year, in October, December, February, April and June. Scores are returned about six weeks after the test. Finally, there are application deadlines for the actual programs, which vary from rolling admissions to specific deadline dates. Many application deadlines are in January, and even if they are rolling, early applications are more likely to get funding.
Spring of your junior year is a good time to start investigating possibilities, though the fall of your senior year is usually not too late. It is best to take the GRE in October, since December scores are often too late for the first round of funding decisions.

IV. ADMISSION

An important point about where to apply is that for graduate school in contrast with undergraduate school, it is more important who you study with rather than where you study (although funding concerns may temper this in some cases). Admission to a graduate program, unlike undergraduate school, is not done by a large impersonal office, but by the faculty involved. So, If you visited the school, made contact with individual faculty, shown yourself to be a good “fit” with their program, your chances of admission are improved substantially. While grades and GRE scores are important (especially for fellowship awards), the most important credential is the student’s research interest, as demonstrated by experience and faculty recommendation. At present it is a “Seller’s Market”, wherein the prospective graduate student is the seller. Graduate applications are down (although now rising) and most programs are anxious for good applicants. As always, the best programs and labs are hard to get into, but overall the opportunities are excellent. Demographics show that the job market will improve greatly over the next ten years, so the prospects for future employment are encouraging.

V. FUNDING

Students should expect a full tuition remission plus a stipend (for living expenses) while working toward the Ph.D. in the biological sciences. Funding may come from fellowships or research and teaching assistantships.

VI. COURSE OF STUDY

The biggest difference between graduate school and undergraduate school is the emphasis on independence and initiative. There is much more isolation, and after some coursework, goals and deadlines are generally self-generated (though there may be maximum limits!). This can be a serious problem for students who like being told what do, but it is very liberating for self-motivated and creative students.

The structure of most graduate programs may include the following phases: Standard *coursework* (during the beginning years, may fill in or further embellish undergraduate studies); *teaching* (how much, at what stage, varies with different programs); *research* (students sometimes begin by rotating through several labs before settling on a project/sponsor, and then commencing work leading to a dissertation project). In addition to conducting research, the Ph.D. candidate may attend professional meetings; present papers; and participate in graduate seminars and journal clubs. Often, a preliminary or comprehensive exam is required before the student is accepted as a bona fide Ph.D. candidate. The period prior to the preliminary evaluation may be about two years; thesis work may take 2-3+ more years. During the latter period, the student will select committee members who will have input into the project, the thesis, and the final defense.

When the project has reached an adequate stage of completion, thesis writing will begin. A thesis contains the following sections: abstract, historical background, introduction/rationale; materials and methods, results (data); discussion, and conclusion. In some cases, students are encouraged to write up their research as a series of papers for publication (rather than as a formal thesis). The thesis will be reviewed by the sponsor and committee members while it is in process. It will be critiqued for style, design, interpretation and completeness. When deemed acceptable, a defense date will be set. The defense is a “public” hearing of the peers and is attended by other students and faculty as well as the committee. The research is presented by the candidate, often with visual aids, in a seminar format. Questions may be raised by the audience, and a discussion usually follows. At the conclusion of the “public portion”, all except the committee members leave, and the floor is open for intensive grilling of the candidate. When this is over, the candidate leaves and the committee members meet in private to determine approval/rejection. If approved, the thesis is signed and dated. Much rejoicing follows.

VII. AFTERWARDS

Considerably prior to the defense, the candidate begins making plans for the "hereafter". If an academic career is anticipated, these plans usually involve seeking a postdoctoral fellowship position. This is a research post, usually at another institution, which provides a paid opportunity for several years of research in a specialty area. It represents a period for further growth in research; generally, no teaching is required. Often, numerous publications are generated. Post-docs may be supported initially by the host investigator's funding or may apply for their own funding from some agency. Post-doctoral fellowships may last 2+ years; length is quite variable. Following this period, the individual should be ready to apply for a full academic post.

The Ph.D. does not necessarily restrict the recipient to an academic career. Other opportunities do exist, depending on training. For example, there are opportunities for research in industry; government; private research institutes; primarily teaching institutions (including colleges, jr. colleges, private or secondary schools); consulting firms

VIII. OTHER GRADUATE SCHOOL ROUTES TO RESEARCH

Master's Programs

A Master's degree may be an avenue to the Ph.D. or an end (or beginning) in itself. It may qualify the holder for some college or secondary school teaching posts, as well as research assistant or associate positions in universities, industry, or government.

MD/PHD Programs

MD/PhD programs train the student for the practice of medicine as well as academic research. This is a lengthy route, but an appropriate choice for those wishing careers in academic medicine. If *either* clinical practice *or* purely academic research is the principal goal, both degrees may not be necessary. Certain programs leading to both degrees, Medical Scientist Training Programs (MSTP), are *funded*: a relief from the heavy financial burden of medical training alone.

Medical School

Research training is not a part of the medical school process per se. However, there are many opportunities for MDs to develop research skills if training is sought. This may be through postdoctoral fellowships (as PhDs undertake) or as part of training programs for various clinical specialties. With additional training, an MD may find an academic/clinical appointment a fulfilling career choice.

THE ADVICE COLUMNS

From MARVYN STEELE, Ph.D.

A former graduate student at Brown University, in Molecular, Cell & Developmental Biology; presently working in industry:

1. Decide what you want to do in grad school. Many people just say they want to go to grad school but they neither know what they want to study nor what they want to accomplish after they arrive. So that's why I always tell people to decide what they want to do in grad school before applying.

2. Determine what parts of the US (or world) you want to live in. I knew that I didn't want to be in the Southeast so I had ¾of the US that was still interesting to me.

Find out what grad schools are in the geographical regions you want to live in. Peterson's Guide is useful for this!

3. Find out if the grad schools in the desired regions have departments in the field you're interested in. Consult the faculty you at your undergraduate school! Also, Peterson's Guide is useful for this type of information.

4. List all of the professors that work on questions that are interesting to you in the schools found in the last step. Those guides list professors and their interests too!

5. Write a brief letter to *all* of the people you've listed. In the letter, tell the person you're considering graduate school at their institution, that you're interested in their research, and that you're interested in working in his/her lab. Ask him/her if there is space for an incoming grad student in his/her lab. This is truly a task for a word processor with merge capabilities. If you don't know how to use them, this is the ideal time to learn!

6. Of the people that respond positively to you (i.e., say that they are interested in you and have space for you in their lab), write to the graduate school for an application packet.

8. Apply to the graduate school.

9. Of the schools that accept you, set up an appointment with all of the people you're interested in.

10. Go to the interviews. It is AMAZING how different some people are on paper and in life. If you don't feel comfortable with the

professor, cross him/her off your list. You *need* to like your advisor *a lot*! If you don't feel comfortable at the interview, it probably won't get any better as the years go by!

11. List all of the people who responded to you positively in the interview.

12. Select the school that gives the greatest number of likeable people in one place. Sometimes an advisor doesn't work out and you need to go to another lab. It is therefore essential to have more than one potential advisor in the same school.

13. Once you're in, plan your project with your advisor and settle down for the long, long haul of grad school!

From ANDREW GULICK, Ph.D.

ScB Biochemistry, '89, Ph.D., University of Wisconsin (Dept. of Oncology)

Ideally, this essay would be titled "How to get into Grad School". I feel, however, that such a title would be rather ambitious. "One way that worked for me" seems a more appropriate choice. On applying to grad schools, I found myself getting a wide variety of advice from many different directions. Since it was impossible to follow everyone's advice, I decided to pick and choose from the various pieces of advice. The strategy that I chose worked for me. What follows is mostly a compilation of what I did, interspersed with the things I would have done differently if I had the chance. Good luck.
The first question to be addressed is Why go to grad school? Most schools do not offer a Masters program in the sciences, so grad school would require a four to six year commitment to earn a Ph.D. A Ph.D. program usually consists of two years of courses and then three years of doing your thesis research. After the first two years, you must take a "prelim" at the school which usually involves an oral/written exam that says you are prepared to continue. After finishing your thesis, you would be trained to enter research in either an academic setting or in industry. A Ph.D. is, as one professor tod me, a "license to do research." It also allows you to teach at most universities. One other advantage of grad school is that for the first time, the money will be flowing in the other direction. In the sciences, most schools find ways to pay you through research or teaching assistantships.

One way to find out if grad school is where you want to be, is to start working in a lab at Brown. One of my biggest regrets is that I waited until the summer after my junior year to start real lab work. Besides a view of what lab work is like, having experience in a lab also gives you something to talk about when interviewing or writing application essays. I strongly recommend starting early. Remember, however, I did not start early and still got into grad school.

To find the right school for you, it is necessary to do a great deal of research. It is best to have some idea of what you want to do. At this point, there is a certain limit on how specific you have to be. Obviously, the more precisely you can predict what you want to do, the better. It is not necessary, however, to be able to define your research project to find the right school. The best place to find what sort of graduate programs are available is the Peterson's Guide. This set of books lists schools by departments that range from Ecology to Molecular Biology. Each school has a page of information about its program and a page listing the professors and their research. These books are a wonderful source of addresses to which you can send for more information, which will really tell you what the professors are doing. Also, talk to your professors at Brown about their research, and where in the country similar work is being done.

When you narrow your choices of schools you will apply to, do not pick programs that have only one professor with whom you would want to work. Try to find departments where you could conceivably see yourself in one of several labs. If you apply with only one professor you would want to work with, you might arrive and find out that you do not get along with him or her, or that he or she just got a new job, and then you are stuck. Allow yourself the flexibility of choice once you get to the school.

Most applications are due sometime around the middle of January. The applications are much more straightforward than were those for college. Much less emphasis is placed on what you did outside of classes. They are usually a page or two on your vital information: name, address, classes taken, etc. The rest of the application is an essay. All of the application essays ask basically the same question. "What have you done, and what would you like to do?" In the essay, it is good to talk about any research or teaching experience that you have had. Then tell them what your future research interests are. One of the biggest dilemmas that I had in applying was whether to name specific professors with whom I would like to work. In the end, I chose not to.

Other people choose to write in their essays, "Of particular interest to me would be working in the lab of Dr. So-and-so". Either way works, so you should do whatever you feel comfortable with.

The only other things that most schools require is your transcript, and the GREs. When preparing for the GREs, keep in mind that all biologists take the same test. The test is broken down into three subsections. It is most important to do well on your subsection, and you really are not expected to do fantastically on all three. A really good way to prepare for the biology test is to review your notes and text from Biology 20. This will give you the best review in a limited amount of time, as it would be nearly impossible to review material from every biology class you have taken.

After applying, the next step is the interview. Grad school interviews differ from Med School interviews in nearly every way

imaginable. Once you have reached the interview stage, the schools pretty interested in you, and many schools will pay for your travel and lodging to look at the school. The interviews that I had were all very similar, and all very relaxed. Your day at the school involves talking with a number of faculty members, and usually lunch with a few students from the department. The meetings with the faculty each last about thirty minutes. They usually ask you about your lab experience, and then use the remainder of the time to tell you about their own research. I did much more listening than talking in each of my interviews. Remember, they are already interested, and at this point they are trying to convince you why you should attend their school.

When talking to the grad students, try to get a feel for the department. How involved are they in their search? Are they merely robots, or do they give input in what they are doing? How well does the program prepare them in presenting research? Writing grants? Teaching? Students are also a source of information on the non-academic side of the school. How affordable is housing? Is it easy to meet other graduate students?

The only other advice that I can give is to reiterate what I said in the first paragraph. This is one person's perspective on the application process. Do not try to follow exactly what I've said here, nor exactly what any of your professors or advisors have to say. Talk to different people, including the TAs you have had at Brown, and put together a scheme that will work for you. In the end, it is your choice, and you should feel comfortable with what you are doing.

From RAVI CHANDRA

ScB Biology, '89; MD/PhD (Stanford University)

Are you captivated by your experiences in research? Do seven more years of school after college sound exciting, or at least palatable? Having a tough time deciding between graduate school and medical school? Read on – perhaps doing both will be the best way to satisfy all your interests.

Many graduate and medical school applicants these days are finding that pursuing both degrees is more attractive than pursuing either degree alone. What are the advantages to getting both an MD and a PhD? At the most basic and immediate level, this is a challenging and intriguing way to spend seven years of your life. After two years of basic science, you are freed from the rigid classroom lecture format and allowed to stake out an area of research as a full-time graduate students. You will have spent one or two summers before this doing lab rotations, getting to know researchers in your fields of interest. Then, after two to four years and a PhD dissertation, you will return to the medical curriculum for one year of clinical training before graduating. The other advantage is financial: Medical Scientist Training Programs (MSTPs) pay for your tuition, and give you a stipend to boot. If you want to eventually pursue medical research, it helps to not have enormous loans influencing your career decisions.

The idea of combining graduate and medical training was highly appealing to me: the two seem complementary, each emphasizing different ways of thinking and learning. Each half of your training will inform and direct the other half. Medical school is fairly rigid, and quantity of information is stressed; you are asked to remember and regurgitate as many facts as possible. In graduate school, quality of information is given highest billing; you get to focus on a particular problem, and your creative and technical expertise are called upon to solve it. You learn to think as a scientist. Hopefully, as you return to the clinical setting in medical school and during a residency, you will appreciate the connections between scientific research and practice and advancement of medicine. By then, you will be trained for a career in academic medicine, a full-fledged member of both the scientific and medical communities.
Where do you start? First of all, you should have at least one summer of research experience, and preferably more. Much of the application and interview process consists of describing your personal involvement in a research project, and you'll want to have plenty to talk about. The initial steps in applying to MSTPs are identical to applying to medical schools. Near the front of the Medical School Admissions Requirements Handbook is a list of nearly 30 schools that receive NIH funding for their programs. To me, this was a kind of governmental stamp of approval, and ensured that the programs were well-developed and administered. However, there are many schools that construct their own programs independent of the NIH; this indicates a healthy institutional commitment to the MSTP idea, and these schools should not be overlooked. Since you will be doing the majority of your work in graduate school, it pays to look for the strongest graduate programs in your fields of interest, NIH funded or not.

You will receive MSTP applications after you submit your medical school applications and indicate an interest in the dual degree alternative. After those forms are in, you will (with luck!) be invited for interviews. For me, the interviews are absolutely the best part of applying to MSTPs. I actually felt sorry for the people who were just applying to medical schools. They only got one or possibly two short interviews followed by a tour. At each school, I actually got to talk to three to five professors and MSTP trainees, the director of the program, and was often treated to a free meal, or even a free plane trip and hotel accommodations! Seriously, it was a relief and a thrill to talk to scientists about their work, and describe your work to them, rather than talking to a med school interviewer about yourself and what makes you such an ideal person to accept. By early spring, you should have heard from some of the schools at which you interviewed. Over the next few months, you will be faced with some important decisions. Hopefully, talking to people involved in the program will help you make the final decision of whether it is the right path for you. Another worrisome decision you may face is a choice between a fully funded MSTP position at School A or a non-funded position at School B as strictly a medical

student. You could take the non-funded position, and then re-apply to School B's MSTP during your first year of medical school. Your chances for funding are usually better as a medical student, since you have shown commitment to School B's program. However, turning down School A's lucrative offer and paying School B's tuition for at least one year may be more than you (or your parents) can stomach. To hedge your bets, it may be a good idea to apply to the PhD programs of the schools at the top of your list, as well as their MSTPs. (PhD programs are sometimes less competitive, at least numerically.) That way, if you are accepted into one of these schools' MSTPs or PhD programs, you will have funding, and therefore, choice.

If you are still doubtful about pursuing this long, arduous path, perhaps Lewis Thomas' reminiscences about his medical education in *The Youngest Science: Notes of a Medicine-Watcher*, will be of help.

"The MD program was not then, and still is not, very satisfactory training for research in biomedical science. Then, as now, the PhD program provided a much more rigorous and profound experience in science, with a better ground in the basic fields of biology needed for medical research. Earning an MD has, however, one enormous advantage which makes up in part for its deficiencies. After four years of medical school, it is impossible to think about a problem in biology, or to read a paper without having part of one's mind trying at the same time to make connections with human disease."

From HELEN SHIH

ScB Biology, '95, MD/PhD (Radiologist)

Pursuing an MD/PhD was not a simple or immediate decision. While I have always been interested in the biological sciences, I had been set upon a straightforward premedical path since high school. Shadowing physicians at the Rhode Island Hospital only strengthened my attraction towards clinical medicine. However, the summer following my first year at Brown, I worked in a laboratory on campus that was involved in cancer research. This brief exposure to research introduced me to an entirely new world of medicine. I was also exposed not only to a new type of laboratory bench work, but also to new people. I became acquainted with several graduate, medical, and MD/PhD students during that summer. Because of my favorable experience with research that summer, many people suggested that I pursue an MD/PhD degree.

At first, I simply would not entertain the idea. 7-8 years to complete the program? I wanted to be done with school: the sooner, the better. But over sophomore year, my outlook began to change. What did I want to do in the end? That was the key question. I was interested in clinical oncology and patient contact, but I was unsatisfied with the limited knowledge and current treatment of cancers. I was comfortable in the lab and inspired by the challenge to uncover, discover, and develop the vast knowledge that remains largely unknown. While I am as yet unsure of the balance of benchwork and patients in my future career, I do know that I want to be involved in both spectrums of oncology. I believe that with the combined degree, I will be equipped with the optimal background and given the greatest flexibility to pursue my goals in both laboratory research and clinical medicine.

For those who decide that the combined degree is a future endeavor that they wish to pursue, be aware that laboratory experience is vital: the more extensive, the better. As an undergraduate, wetting your feet in some research is your best preparation. Possibly more than anything else, the MD/PhD programs seek for individuals committed to research. The product of the programs are medical scientists, most often pursuing careers in academic research. For those dedicated to clinical medicine but uncertain of their interests in research, be aware that you can do both with an MD, but not with a PhD.

When the tables are finally turned and you have the wonderful dilemma of choosing between programs, be critical in your evaluations. For me, program excellence was my first consideration. Which school offered the best combination of clinical training and research opportunities in my specific area of interest? Other important considerations are the funding packages (many schools pay for all your medical and graduate years and provide annual stipends), the size of the programs, the average years to complete the program, the level of integration of the medical and graduate studies, the location of the school, and the future impact that a school may have on residency placement and/or postdoctoral position. Last but not least, *talk* to the students. Are they happy? Not all students are happy and they will tell you so. Students are troubled by different aspects depending upon the school and program, but they will tell you the most accurate information because they are experiencing firsthand what you may also choose to go through. Ask them about classes, professors, laboratories, and facilities. And ask them about the lifestyle, the town/city, safety, and cost of living. The last note that I would like to leave with you is that when you are beginning to despair, doubt, or become overwhelmed by the application process, stop and take a breather. Remember the key question: *What do I want to do with my life?* If the combined degree is suited to you, you'll always come back to feeling right about it. This isn't 7-8 years of schooling. This is the beginning of what you've always wanted to do: clinical medicine and basic science. When you finally earn your degrees, know that it is only a marker in your life. Science is continuously progressing in leaps and bounds. Learning will always be an endless process.

From VANESSA TONEY

Brown Medical School MD '06/PhD '04

I am a student in the MD/PhD program at Brown University. I completed two years of pre-clinical course work (med years 1 and 2), 5 years of research, and I am currently doing clinical rotations through various fields of medicine at Brown affiliated hospitals. I chose to do an MD/PhD for a practical reason. I loved research, however I learned about the difficulty in maintaining a vibrant research career. In order to shield myself from the need to "publish or perish", I decided that a combined degree in medicine could enhance my research questions as well as provide an immediate outlet to improve patient health.

Many people view a PhD. as means to a successful career in academia, government or industry. This is true, however, there is also merit in the process. A graduate student who progresses to Doctor of Philosophy:

~ Becomes an expert in his/her field of research
~ Demonstrates the ability to explore his/her ideas, as well as ask and answer interesting questions
~ Thinks critically and has an enhanced ability to analyze data
~ Creates/Discovers/Uncovers the knowledge around us

Graduate school is also an ideal place to improve your research, teaching, writing, oral communication, and technical skills. Much of the emphasis of grad school is placed around learning how to ask and answer interesting questions. This involves knowledge of basic biological mechanisms, acquiring technical expertise (PCR, EKG interpretation, Surgical techniques etc.), and learning how recent research findings can help to address your questions.

Graduate school is also a great place for people who like to teach and write. Most graduate students are Teaching Assistants for at least one semester. For those who enjoy teaching there are vast opportunities to teach in the classroom, at departmental seminars, and in the laboratory. Most grad students are responsible for teaching undergrads and new lab members required or supplemental laboratory techniques. Grad students may also play an instrumental role in mentoring and instructing undergrads and junior members of the lab on the ins and outs of becoming a good scientist.

Graduate students are expected to publish articles and may participate in grant writing. Early in your career you will be guided by your mentor and eventually learn to operate more independently. Finally one of the major perks of grad school is the opportunity to present independent research at seminars, research forums and poster sessions at home institutions, national and international conferences. Conferences also present a wonderful forum to exchange ideas and establish future collaborations. (When choosing a lab try to find out if grad students participate any, most or all of the activities stated above.)

Commonly asked questions:

Q: Are there any good books which can help me navigate graduate school and or help me to decide if graduate school is right for me?

A: Yes. I highly recommend following books. In addition you should get more information on specific programs via the internet.

~ *Peterson's Graduate Schools in the U.S.* by Peterson's
~ *Getting what you came for: The Smart Student's Guide to Earning an MA or a Ph.D.* by Robert Peters.
~ *The Ph.D. Process: A Student's Guide to Graduate School in the Sciences* by Dale F. Bloom, Jonathan D. Karp, Nicholas Cohen

Q: Who should do an MD/PhD?

A: #1 People who love research and who have an interest in disease processes and manifestations. I weigh the love of research above the love of clinical medicine and patient care b/c it is possible to do research without an PhD. Therefore, you better really like research if you want to dedicate an additional 3-5 years. The best way to know this is early exposure in research activities at Brown or other institutions (summer programs, independent study courses in clinical or laboratory science).

Q: *Why do a PhD if I can do research as an MD?*

A: PhD's invest many years in learning to do science and as a result may be more competitive than an MD who never received formal graduate training.

Q: *Should I do an MD/PhD as a way to decrease loan amounts?*

A: If your sole reason is financial, you would probably make out better financially in the long run if you took out medical school loans, and then pursued a high paying specialty? Many MD/PhD programs are subsided to encourage students to pursue research careers in academic medicine, which traditionally has lower salaries than doctors who spend 100% of their time in patient care.

Q: *Can a PhD help me to get into a more competitive residency?*

A: Yes, because you have all the skills listed in the essay above. However, because you took several years off to do a PhD some of your initial grades may be lower than other classmates who are closer to their pre-clinical course work.

Q: *What is an alternative for someone who wants to do an MD, but does not want to invest the time in a PhD?*

A: Master of Medical Science is a popular choice for medical students who want to pursue research in a particular area (ie., Opthomology, orthopedic surgery, cardiology etc,. There are also opportunities like Howard Hughes at the NIH for medical students to pursue research for 1 or 2 years.

Q: *Are there ways to acquire outside funding for MD/PhD programs that are not MSTP (fully funded programs)?*

A: Yes. Brown's MD/PhD program covers 6 years of tuition (4 years graduate school + 3rd and 4th year of medical school). Many of our students apply for National Research Training Awards (NRSA) sponsored by the Public Health Service Corp. These are 5 year grants which can be applied anywhere during the program. If medical year one is to be covered, the application must be submitted several months before matriculation. This is impossible for most students, so the grant can begin in year 2 if the application is in by medical year 1. NRSA awards are restricted either to specific fields of research including environmental health, mental health (and others), or to under-represented minorities in any field. See: http://grants.nih.gov/training/nrsa.htm

Q: Can you have a family while in graduate school?

A: By the final year of the MD/PhD program many students are married and some even have children. However, for student-parents to be successful they must be organized and have very good support systems. Some schools provide subsidized child care and are amenable to schedule adjustments for child birth and maternity leave etc. Also, it is important to talk to other student-parents in your intended department or at the school (particularly if you are moving to a new place and already have children).

Q: Are there special considerations that minority students should take into account?

A: Most of the advice stated above is universal. However, minority students may want to ask about retention rates and the career paths chosen by minority graduates. It is also important to know about support systems in place for minority students. Does the Graduate Program or Medical School have a dean of minority medical affairs? Is diversity and the development of minority scientists and/or physicians important to that institution? Are there active minority graduate or med-student clubs on campus? If not, find out if minority students ever connect with students from near-by campuses. Does the city/town/school provide an atmosphere and resources which will allow you to thrive? If possible ask to communicate with other minority students in the program by phone or e-mail. You may also try to seek out students from Brown (your undergraduate institution), or home town. Pursue a NRSA minority fellowship or UNCF Merck Scholarship for graduate school (See financial question).

From NANCY THOMPSON, Ph.D.

Associate Dean of Medicine Graduates/Postdocs, Brown University

As a Brown undergraduate, if your grades are reasonable and you have some research experience that you can write and speak about knowledgeably, you are likely to be offered a position by most PhD programs to which you apply. This is a different situation than most medical school applicants will face. Enjoy the situation as you seek the program that is the best fit for you.

An undergraduate contemplating graduate school should try to answer the question: "What do you see yourself doing 10-15 years from now?" Why? This will give a clue as to your underlying goals and career passions. It may be as a professor at a small liberal arts college. It may be as the head of a research group at a pharmaceutical company or biotech start-up building on your own intellectual property and research initiative. It may be that you are interested in uncovering disease mechanisms with hopes of having your work lead to new diagnostics or treatments. Your goal will drive the type of training program that will provide the course work foundation, research areas and faculty mentorship appropriate to realize this end. If you are not sure about the area of research you would like to pursue in your doctoral training, choose a program that offers many choices with a general entry "umbrella" first year curriculum allows you to try out several areas of possible interest before committing to one research focus. It is also important to consider the technologies you will want to become skilled in as a result of your doctoral training. New areas of current vogue such as nanotechnology, bioinformatics, and systems biology are in demand and at the intersection of biology and other disciplines.

You should aim for a highly regarded program at a prestigious institution. One indicator of a program's quality is whether it has one or more federally funded training grants. These may be in a general area such as molecular and cellular biology or in a more topical area such as environmental pathology. Information about training grants may be obtained via internet search or inquiring during an

interview visit.

Realize that being a graduate student is very different from being an undergraduate. You will be expected to put in long hours and invest much intellectual capital in your training. But the thrill of discovery and gaining new knowledge can be highly rewarding. You are developing the professional skill set of a scholar and the pursuit calls for creativity, excellence in communication skills, integrity, problem solving and perseverance, particularly for the times when your research is not going as well as you had hoped.
Think carefully about who you ask to write your letters of recommendation. These are scrutinized carefully by admissions committees. The writer should be those who know you well enough to comment on (guess what): your creativity, integrity, problem solving and communication skills, and motivation in addition to your intellect and ability to master research techniques.

One of the most important aspects of an interview visit will be to evaluate the graduate students who are in the program. Do you see yourself as a colleague of theirs? Ask them about their experiences. Where have graduates of this program gone for further training and career positions? Which faculty taking graduate students? How long is the average time to PhD? How many publications and in what journals are students publishing? What facilities are available (such as proteomics, transgenics, etc) and what is the access for students?

From HEATHER McCREA,

Brown '02, Yale University School of Medicine

Advice for undergrads thinking about MD or MD/PhD programs:

As an undergrad:
You should gain some clinical experience. This can be done by shadowing a clinician or volunteering in a hospital or hospice. When you interview, you are going to have to convince your interviewer that you know about medicine and what it entails and that you are a good fit for the field. Some people volunteer as an EMT to gain clinical experience, but this is often less favored by admissions committees because it does not give you exposure to being a doctor. Similarly, hospital volunteer work that has you sitting at a front desk won't give you exposure either. Shadowing a doctor or working in a hospital Emergency room, hospice, or on a hospital floor where you can interact with MD's is more highly regarded and is probably more useful to you as well. If you don't know an MD to shadow, professors, the biology office at Brown, or maybe even a family friend may be able to help you find one to shadow.

Attending grand rounds conferences at a hospital is also a good learning experience. Grand rounds are conferences usually held weekly by different clinical departments. If you know of a field you might be interested in, you could try to go to the grand rounds for that specific field (ex. neurology, surgery, medicine). However, regardless of what you think you may be interested in, Internal Medicine Grand Rounds is often a good one to start with as it is the most general. Do not be discouraged if much of grand rounds is over your head. These conferences are designed for physicians and residents, but if you attend over a period of time the language will become more familiar. Regardless, it will give you a flavor of how physicians approach a clinical problem.

Doing research is also viewed highly by MD committees and as a necessity for MD/PhD admittance. If you have the opportunity to publish a journal article or submit an abstract to and attend a conference, you should. Gaining a fellowship to support your research (for example a Royce fellowship or UTRA) also looks great. If you don't like your first research experience, you can switch to another. However, overall, it looks better to spend an extended period of time in one lab or on one project than it does to jump around from project to project. It is a good idea to pick a lab based on the mentorship you will receive. However, you will ultimately need to explain how your research is applicable to medicine and whether you want to continue pursuing similar research. You can do research in any field you want, but regardless of what you research, think about whether there is some application of your research to clinical medicine – this can be a direct application now or or a remote possibility of significance in the future.

MD/PhD: If you are interested in applying for an MD/PhD position, the same things above apply to you too – programs will want you to have both clinical experience and research experience. They will expect you to have more research experience than a typical MD applicant, however, and like to see a depth of research – i.e., working in one lab over a longer period of time. Publications and abstracts are great, though it is still possible to be admitted without these. A recommendation from your PI (the person whose lab you work in) is critical. Also, try to talk to some people who are in an MD/PhD program, are graduates of an MD/PhD program, or are MD's doing research and clinical work. They can give you insight into the benefits of doing an MD/PhD and what programs are looking for in applicants.

Application:
The goal of the med school essay is to explain why you became interested in medicine in an essay that also shows who you are. It's very similar in that respect to your college essay where you talked about different things you had done in order to give a sense of you as a person. Some possible things to discuss are your extracurricular activities (music, athletics, community service, etc) and what they have taught you, your research experience, and your academic interests. Try to have several people you respect, including hopefully at least one person in medicine, read your essay and offer you suggestions to improve it. If you are applying for MD/PhD programs, make sure you that you stress your interest in both research AND clinical medicine. Make sure you also research programs well so you can focus on the qualities that are important to each program when you write the supplemental essays they will require on "What interested you in our school of medicine?"

Letters of recommendation:
Letters should be from people who really know you. If you've attended office hours frequently for a professor, taken a small seminar class with a faculty member, or worked in a faculty member's lab, these people may know you best. All letters do not need to come from professors in the sciences, but at least one probably should. In addition to science professors at Brown, you may think about people who supervised you in a volunteer role or clinical experience, someone whose lab you worked in at another institution, a professor you had for a non-science class at Brown, or even a coach. This probably goes without saying, but make sure the person knows you. Getting a letter from someone who knows your parents and just knew you as a little kid is not helpful. In contrast, if this person really knows you in an academic setting or worked with you/supervised you in an extracurricular activity, they might be

appropriate. MD/PhD applicants should have at least one letter from someone whose lab they have worked in commenting on the student's potential as PhD candidate and future researcher as well as the student's potential as a clinician. Remember as an MD/PhD you are applying for both the MD program and the PhD program, so your letters should speak to the qualities that will make you succeed in both fields.

Interviews:

MD:

The structure of interviews can vary from school to school. However, at many programs you will interview with two faculty or student interviewers. In places that use student interviewers, these students may have the same power as a faculty member in deciding your fate; however, they will be much closer in age to you and may be able to answer some of your questions about life at that medical school. The two questions that you are pretty much guaranteed to get asked in some way are: Why do you want to be a doctor? and Why are you interested in our medical school? The best answers to the first question usually explain how one first became interested in medicine and then include some reference to clinical experiences that a student has had and how this confirmed his/her interest. For the second question, you need to do your homework. The school has a good reputation and I like this city are not great answers. Think about the curriculum of the school – do they have grades? Do they teach in small group or lecture? How much time is spent on basic science courses before starting clinical rotations? Do students do research or have a thesis requirement? Focusing on the answers to these questions and how what the school has would be a great fit for you is key. If you know a student at a particular school you are interviewing at, make sure you ask them what the school prides itself on. Some other questions you may be asked include: Tell me about yourself? What is your favorite activity? Or asking you to tell them more about a specific activity you mentioned. What was your favorite class? What is your greatest strength/weakness? Tell me about your research. What are you passionate about? Do you know what area of medicine you might be interested in? (For the last question they don't expect you to really know the answer. Most people change their mind in medical school. However, you may want to think about it, and if you have some ideas, definitely share them and why). Make sure you know your application inside and out. Anything you wrote in it is fair game for questions.

Some interviewers will have read your file and know a great deal about you. Others will not have read your file yet. You may be able to quickly figure out which is the case and adjust what you say accordingly. Think about what you want the interviewer to know about you before you go to the interview. Don't totally take control of the interview, but make sure you get these points across. Also, be prepared to ask your interviewer questions. They will leave time at the end for your questions or in rare cases might start off by asking you what questions you have. Try not to ask questions that could obviously be answered on the school's website. However, it is fair to ask someone their take on something you have asked other people already or on something you have read about. You will get so many opportunities to ask questions, that you may be questioned out by the time of your interviews. Asking someone their take on something someone else has answered is a good way out of this problem.

Having a mock interview before your first interview is a great idea. It will make you less nervous and force you to think about answers to potential questions. If you have shadowed a clinician during your time in undergrad, they may be able to give you a mock interview. Otherwise, if you have a friend who has been through the interview process before, they might be able to help out. Make sure you tell this person to give you their honest opinion. They should tell you what you are doing well but also point out what you should fix. The two biggest mistakes someone can make during an interview are coming across as cocky or being too insecure/not making eye contact. Presenting yourself confidently with direct eye contact is great, but never be condescending or talk negatively about other people.

Attire is another question people often ask about. Dark colored suits (black, navy, charcoal gray) with a plain colored shirt or blouse is an appropriate choice. Women may wear suits with pants or a knee length skirt. Pick whichever one you are most comfortable and confidant wearing. If you do a mock interview, wear your suit to the interview so you get more accustomed to wearing the suit and feel less awkward in it. Remember, you're not the only one who feels awkward all dressed up in a suit. That's common to pretty much everyone.

MD/PhD:

First off, read the above advice for MD's. As an MD/PhD applicant, you are being assessed for your appropriateness as an MD candidate and a PhD candidate. If you cannot make a case for why you want to do medical school, you will not be admitted to an MD/PhD program. If you are not accepted to an MD/PhD program at a particular school but have explained well why you want to do MD, you may be accepted for an MD position. MD/PhD interviewers, like MD interviewers, are looking for people who genuinely want to be a physician and practice clinically. In addition, they want someone who loves research and will be an effective PhD student. The goal of MD/PhD programs is to produce the "triple threat" - clinician, researcher, teacher. Think about whether this is what you want to do and how you would be a good fit for these three things.

MD/PhD interviews differ greatly from school to school. At least one school has a panel interview where multiple faculty members interview you at once. Try not to let this intimidate you. If one faculty member is particularly problematic, other faculty members may cut him or her off. Try to make eye contact with whoever is asking you the question for at least part of the time but also address the whole committee. Most schools though will give you one on one interviews with faculty members. Many schools have you interview with some people on the MD/PhD committee and some on the MD committee though the number of interviewers you will have from each will vary depending on the school. Many programs will take you out to dinner – dress at these dinners varies, but usually they are more casual than the interview. Feel free to ask ahead of time so you know what to pack. Some programs will offer you student hosts, others will pay for hotels and/or travel, and still others will only pay for dinner. Usually programs will outline what they have to offer when they invite you for an interview. Interviews range from one day (which tends to be a really jam-packed exhausting day) to three or four days, but most programs will have two days of interviewing, sometimes with one day being a regular MD interview day and the other day being designed for MD/PhD applicants.

In addition to the common MD questions, common MD/PhD questions include:
"Why do you want to do an MD/PhD?" And "If you had to choose between an MD or a PhD, which would you choose?" The latter can be a tough question, but it is your opportunity to explain why it is so critical to you to do both. A common answer is that one would pick the MD because one can still do research with an MD but one cannot see patients with a PhD. This is a probably the preferred answer, but you need to also explain why it is so important to you to see patients and why you feel your research training would be lacking without a PhD. If you answer that you would rather do the PhD, you need to make it clear that you would really miss working with patients. Also, wanting to work with patients should never just be because you want to study them/have them inform your research. MD/PhDs are expected to have the same genuine desire to help people in a clinical setting.

You will also likely be asked to explain your research in depth. Be prepared to explain exactly what you did, what your overall hypothesis is, how your work fits into the overall work of the lab and the field, and how your work is applicable to medicine. No matter how remote your work is from medicine, there is usually some potential connection. If you have trouble thinking of one, you may want to ask your research mentor if they have ideas. It's fair to admit that it is not closely related (definitely be honest), but if you can envision a potential connection and point to it as a possible link, it will be well received. If you have any publications, you may want to bring a copy to give to your interviewer. Some people verbally discuss their research or bring a notepad to draw out a diagram of what they did. Others find it helpful to bring a printout of a couple slides/potential figures outlining their work. Most programs will let you discuss your research in whatever manner you want though one school has been known to only allow you to verbally describe your project and not allow visual aids or drawing pictures.

You will also likely get asked about how you envision spending your time in the future. The typical MD/PhD model which is often discussed is the 80/20 model (80% research, 20% clinical). Many people view 80% of one's time to be the minimum amount one can spend on research and be successful. That being said, some specialties are difficult to do in this model. Surgical specialties tend to have more of a 50/50 model. Your answer should be informed by what you want to do and how much you think you like research vs. clinical. Clearly your answer is not set in stone. Some possible answers are: 1) I'm very interested in research, and I've heard that in order to have a successful lab, one usually needs to devote about 80% of one's time to research and 20% to clinical. 2) I've heard that people usually recommend 80% research, 20% clinical in order to be able to get grant funding. However, I really like clinical work, so I think I would like to try to spend more than 20% of my time in clinical activities. You can also bring up teaching as well if you would like or feel free to acknowledge that you realize that to be successful your time may need to add up to more than 100%. Your answer should reflect an acknowledgement that research and the clinic will compete for your time and that quite a bit of time needs to be spent on research in order to secure grants, but it should also be your own answer.

Meggan Craft, '97

As a freshman entering Brown University, I was convinced that I wanted to be a physician. "If you like biology, you become a doctor," I had been told by family and friends. Consequently, I hunkered down and plowed through the pre-med coursework with aplomb. Yet, something was missing; I could not find the connection between my classes and the "real world." Doubting my passion for medicine, I pushed myself into myriad jobs and volunteer experiences in an attempt to find my niche.

I began my quest for a "passion" by volunteering in a medical microbiology lab. After a year, I had to admit that his field did not send any sparks of excitement through my body. I was finding the solitary, indoor experience too sterile. In order to try a field with more physical stimulation, I not only worked over summer as a veterinary technician. My love of animals and science, as well as my sociable nature, made this field a good match for me. I not only worked with a small animal vet, but also shadowed large animal and zoo vets. Unfortunately, the veterinarians all told me that if they could do it all over again, they would become physicians. Back I went to the medical field to work as an emergency room intern for a summer to volunteer as a cardiac nurse aid during the school year and to intern in the anesthesiology department of Cedars-Sinai Medical Center in Los Angeles. While I loved the fact that I was finally able to apply some of my "book knowledge," I found that I became too emotionally involved in the patients' illnesses and that the work atmosphere was stressful and negative.

Still searching for my passion, I decided to pursue something a little off the wall: a semester abroad conducting field research in Africa. I was not ready to abandon the medical school dream yet, so had to go through some extra steps (like studying physics over the summer) to make sure I could afford the time off from my rigorous pre-med schedule. Going to Africa was the best decision of my life. During this three-month program, I couldn't get my hands on enough information. I wanted to know everything about the natural world around me. My classes covered material I was sincerely passionate about and doing homework was fun. Suddenly, I found myself reading ahead in my books and chatting, easily with professors. It was obvious that something had hit a cord with me in Africa.

A week after graduating with top honors from Brown, I was back in Kenya interning with the School for Field Studies, where I taught wildlife management. Still unable to abandon the medical dream, I had planned to take only one year off before entering medical school. I now think a panic attack induced by Larium (an antimalarial drug with common anxiety side effects) for bringing me to my senses and helping me realize that my dream was what I was doing! My year off turned into six quick years in Africa. I taught and started Tanzania's first ecotourist adventure company, and conducted lion research. I studied issues of competitive coexistence between lions and hyenas, which has developed into my current thesis project: investigating the ecology of infectious disease among carnivores. By focusing on epidemiological issues, I can now integrate a veterinary and medical angle into my career, tying my background with my passion. I have happily embraced the idea that fieldwork, the outdoors, animals, and ecosystems are part of my life. My long-term plans include a future in wildlife epidemiology, combined with either a career in conservation or teaching. Looking back at the search for my passion, I am only disappointed that I took so long to listen to my heart. the signs had always been there. In my youth, I had excelled at every science project, and my favorite school trips were to Big Bend National Park and a marine biology trip to Galveston. My childhood room was even decorated with lion posters and lion stuff animals.