

Is an MD/PhD program right for me? Advice on becoming a physician–scientist

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ABSTRACT We are living in a golden age of biomedical research in which it is increasingly feasible to translate fundamental discoveries into new diagnostic and therapeutic approaches to human illnesses. Inherited diseases are being cured with gene therapy. Cancer cells are being eliminated with less toxic small molecule inhibitors and reengineered T-cells. Direct connections are being made between the central nervous system and prosthetic devices. These efforts are being led by scientists and engineers, some of whom are also physicians. This article is intended to help anyone considering a career as a physician–scientist, but unsure about how best to begin. It is also intended for faculty, staff, and parents who are on the front lines of advising talented students about the options that they have for their future. With this in mind, I have tried to answer common questions about MD/PhD programs, but I have also included information about other paths to becoming a physician who does research.

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INTRODUCTION

Because this is a perspectives piece, I will begin it with a confession: I have been a physician–scientist for more than 30 years and I like what I do. I am also a graduate of one of the earliest MD/PhD programs and have been director of the University of Pennsylvania's MD/PhD program for 20 years. Being a physician who is also a scientist already makes me atypical. According to the American Medical Association, only 14,000 U.S. physicians (out of nearly 1 million) consider research to be their major job, and a search of National Institutes of Health (NIH) databases in 2012 turned up only 8200 physicians who were principal investigators on NIH research grants (Ginsburg *et al.*, 2014). To put that number in context, there were 28,000 total investigators with NIH grants in 2012. In other words, most NIH principal investigators are PhD scientists, not physician–scientists (MD or MD/PhD).

My primary day (and sometimes night and weekend) job as a card-carrying physician–scientist is overseeing an NIH-funded research team. My clinical responsibilities include taking care of patients with the kinds of bleeding and blood clotting disorders

that we study in the lab. Some of these patients have medical problems that are common in the United States. Some of them are true “zebras,” the kinds of patients who get referred to a well-respected academic medical center because physicians are unsure how best to proceed or lack the resources to manage the patient's problem. I also teach medical students and graduate students, and I direct a very large MD/PhD program. In my spare time, I talk to lots of undergraduates and recent college graduates who are thinking about becoming physician–scientists and wondering whether they should be applying to MD/PhD programs. I meet them at Penn, but also on visits to other colleges and universities. This article is a distillation of some answers to questions that I am commonly asked. If you are an undergraduate trying to decide whether to go to medical school, graduate school, or both, this article may help you. Whatever you decide, I wish you success.

WHAT IS THE PURPOSE OF MD/PHD TRAINING?

MD/PhD programs were established in the 1950s to combine training in medicine and research. They were specifically designed for men and women who wanted to become research physicians, also known as physician–investigators or physician–scientists. Most of the graduates of MD/PhD programs in the 60-plus years since then have become faculty members at medical schools and universities, investigators at research institutes such as the NIH, or leaders in in the pharmaceutical and biotech industries (Brass *et al.*, 2010). Regardless of where they eventually end up, MD/PhD trainees are being prepared for careers in which they will spend most of their time doing research or translating that research into new therapeutic and

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*Address correspondence to: Lawrence F. Brass (brass@pennmedicine.upenn.edu). Abbreviations used: AAMC, American Association of Medical Colleges; MCAT, Medical College Admissions Test; MSTP, Medical Scientist Training Program.

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diagnostic approaches. It is a busy, challenging, and hugely rewarding career. A study of what has happened to MD/PhD program graduates from 24 schools appeared in *Academic Medicine* in 2010 and is worth reading not only for the data set, but also for the discussion of what the data mean (Brass et al., 2010). An even larger outcomes study that includes data on over 10,000 MD/PhD program graduates is scheduled for publication as a AAMC report in April 2018 (Akabas et al., 2018).

HOW CAN ONE PERSON DO TWO JOBS?

When I was an undergraduate and trying to decide what to do with my life, my mentors told me that I could become a doctor or a scientist, but that trying to combine two busy professions was futile. Many years later, I know that many current undergraduates are being told the same thing. However well-meant, that advice misses the point. The goal of MD/PhD program training is not to prepare you for two unrelated full time jobs. Instead, you should think of physician–scientists as chimeras—blends of a physician and a scientist with the two parts fitting closely together. A more relevant question is: if you are going to become a physician–scientist, do you have to go through an MD/PhD program? I will try to answer that one a bit later in this article. First, I'll provide some definitions.

WHAT IS THE DIFFERENCE BETWEEN AN MD/PHD PROGRAM, A COMBINED DEGREE PROGRAM, AND AN MSTP PROGRAM? A BIT OF HISTORY AND A WORD ABOUT FUNDING

None. Programs designed to train physician–scientists go by all of these names. For the most part, the terms are interchangeable, although at some schools “combined degree” programs can include MD/JD and MD/masters programs as well—also VMD/PhD programs, which train veterinary physician–scientists. A list of MD/PhD programs can be found at www.aamc.org/students/research/mdphd/applying_MD/PhD/61570/mdphd_programs.html. The NIH uses the term MSTP (short for “medical scientist training program”) to refer to programs at schools that have been competitively awarded special training funds to help support MD/PhD candidates. There are currently 46 MD/PhD programs that receive support from the National Institute of General Medical Studies. A list can be found at www.nigms.nih.gov/Training/InstPredoc/PredocOverview-MSTP.htm.

When they first started, there were only a handful of MD/PhD programs. I can clearly remember reading a small booklet about applying to medical school that had a single page at the back about MD/PhD programs. Over time, the number of programs has grown. Now there are ~90 active MD/PhD programs that admit anywhere from a few students per year to 25 or more. The average size of an MD/PhD program in 2017 was ~90 students in all stages of training. Compared with the many thousands who apply to medical school in each year, only 1900 (~3%) apply to MD/PhD programs. About one-third of the applicants are accepted, which is similar to the acceptance rate for medical school.¹ When I began medical school, there were very few MD/PhD trainees—I was one of two in my entering class. That has changed considerably. There are currently ~5500 men and women in training in MD/PhD programs.

Most MD/PhD programs provide tuition waivers for both medical school and graduate school plus a stipend to help cover living expenses. Such fellowships are exceedingly valuable for trainees and very expensive for medical schools and the NIH, so admissions committees work hard to pick the right students for their programs.

¹www.aamc.org/data/facts/enrollmentgraduate/.

Despite the high training costs, when I visit other MD/PhD programs to conduct reviews, it is not uncommon to hear deans refer to their MD/PhD program as “the jewel in the crown.” One can easily argue that the existence of MD/PhD programs is evidence of the high value that our society places on physician–scientists.

ARE MD/PHD PROGRAMS LIMITED TO THOSE INTERESTED IN LABORATORY RESEARCH?

The answer varies from school to school. Not all schools offer PhD programs in all disciplines. The majority of MD/PhD students receive their PhD in biomedical laboratory disciplines such as cell biology, biochemistry, genetics, immunology, pharmacology, neuroscience, and biomedical engineering. The names of departments and graduate programs vary from school to school. At some schools, MD/PhD trainees do their graduate work outside of the laboratory disciplines, in fields such as economics, epidemiology, health care economics, sociology, medical anthropology, or the history of science. This is not an exhaustive list, and you should check before you apply to see what is actually offered at any particular school.

Although there is no fully up-to-date and reliable list of which MD/PhD programs offer training in which graduate disciplines, a place to start is at the Website of the AAMC MD/PhD section (which is a good source for other types of information as well).²

ARE THERE OTHER WAYS TO BECOME A PHYSICIAN–SCIENTIST?

Yes. Definitely. MD/PhD programs are a great choice for people who decide early that they want to be physician–scientists and have built the necessary track record of academic success and research experience before they apply. Not everyone does this, however, either because he or she did not learn about the option early enough, he or she did not make a decision in time, or he or she does not have an academic and research experience record that supports an application. Not finding out early enough turns out to be a common problem. In my experience, college prehealth advisors know much less about MD/PhD training than MD training—not surprisingly, since only 3% of medical school applicants in the United States every year apply for MD/PhD training. As a result, some people choose (or are obliged) to do MD/PhD training in series, rather than parallel—finishing one degree and then starting the other. The disadvantages of this approach include taking longer to finish training and the likely need to cover the cost of medical school on your own.

I am frequently asked about the strategy of starting medical school and then applying to graduate school as a medical student. Some schools will consider you for transfer into their MD/PhD programs after you have completed a year or two of medical school or graduate school at the same university. Although it is very rare that an MD/PhD program will consider accepting a medical or graduate student from a different school, it does occasionally happen when faculty move from one institution to another and want to bring their students with them. The rules and requirements vary from school to school.

Other programs worth checking out include the NIH MD/PhD program that provides support for the PhD phase at the NIH campus or in Oxford/Cambridge, with the MD training taking place at one of the participating MSTP-designated programs. Note that not all of the MSTP programs have chosen to participate, so if you have your heart set on a specific medical school, you should be sure to ask.³

²www.aamc.org/students/research/mdphd/.

³<http://mdphd.gpp.nih.gov>.

Another option is to complete medical school and residency training before doing an extended period of supervised research. A number of Nobel Prize-winning physician-scientists did just that. However, with the increase in the number of MD/PhD training programs nationwide, most people who make the decision to become physician-scientists while still in college should think hard about doing both degrees together in an integrated MD/PhD program that combines graduate school and medical school into a joint program that currently takes 8 years on average to complete (Akabas *et al.*, 2018).

DO I REALLY NEED A PHD TO DO RESEARCH? CAN I SAVE TIME BY SKIPPING IT?

The answer to the first of these questions is “Clearly not.” However, while medical school will put you firmly on the path to becoming an accomplished clinician, it does not provide training in how to do research. At some point you will benefit from that additional piece of your education if you intend to become a physician-scientist.

As noted above, in years past it was not uncommon to learn how to do research by doing an extended postdoctoral fellowship after (or instead of) a clinical residency. I am often asked whether it is possible to save time on the path to becoming a physician-scientist by skipping graduate school and just going to medical school. The available data suggest that the answer to this one is “No.” Physician-scientists get their first jobs in academia and their first independent NIH grants at approximately the same age regardless of whether they completed an MD/PhD program or went solely to medical school and then did a more extended postdoc (Ginsburg *et al.*, 2014). As a result, I normally tell undergraduates that if they are ready to make the commitment before starting medical school, MD/PhD programs offer many advantages, including integrated training, mentored research training, and medical school tuition waivers. On the other hand, if you are sure you want to be a doctor, but less sure about being a scientist, then my advice is to go to medical school and figure out the rest of what you need when you know more about the opportunities that being a physician provides.

HOW DOES MD/PHD TRAINING WORK AND HOW LONG DOES IT TAKE?

The answer varies from school to school, but historically students begin with 2 years of medical school, switch to graduate school in

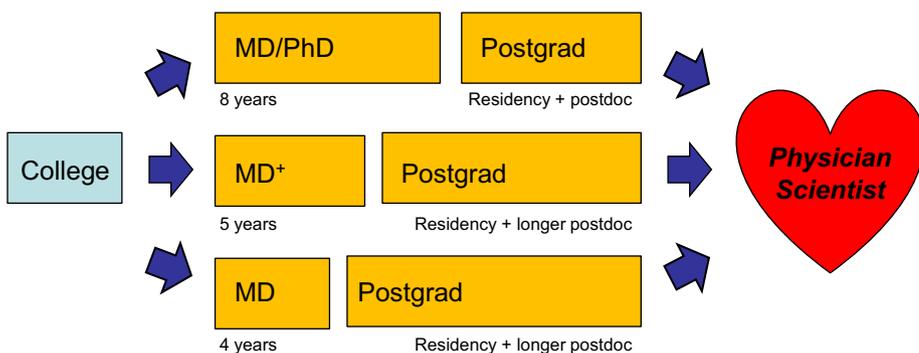


FIGURE 1: Paths to becoming a physician who is also a scientist. Integrated MD/PhD training programs that combine research and medical training are not the only path to becoming a physician-scientist. Alternatives begin with doing a research year in medical school (MD+ in the figure) or just doing the standard four-year medical school education. These save time at the start, but usually require a longer period of postgraduate clinical and research training to reach the point where a job as a physician-scientist in academia becomes feasible. As a result, physician-scientists often arrive at the “get a job” point at about the same age whether they began as medical students, MD+ students, or MD/PhD students, although usually with greater student debt if they have not been in an MD/PhD program. See the text for details.

the third year of the program, and then return to finish medical school after completing (and defending) a thesis research project. When I was an MD/PhD student in the 1970s, there was little, if any, communication between the medical and graduate phases of the program. That has changed considerably. Now most programs emphasize integration of the MD and PhD parts of the training, with graduate school courses during years 1 and 2 and clinical experiences during graduate school. Some programs allow completion of 3–12 months of clinical training before the start of full-time graduate training. Be sure to ask how things are organized at schools that you are considering. In programs leading to a PhD in laboratory science, MD/PhD trainees usually spend the summer between the first and second years of medical school working in the laboratory of the faculty member they are considering as a potential thesis advisor. Some programs also ask students to do one of these “lab rotations” in the summer before starting medical school classes as well. Depending on the number of clinical months completed before starting the thesis research, students returning to medical school will need 1–2 years to finish their training and meet the requirements for medical licensure. The stated goal is to complete an MD/PhD program in 7 or 8 years. However, numbers from across the country show that some students finish in 6 years, while others take 10 years (or more). The average currently is 8 years (Akabas *et al.*, 2018). Note that medical education in the United States continues to evolve. One trend is away from the classic two years of preclinical education followed by 2 years of clinical education. The earlier start in clinical training made possible by shortening preclinical time enables some MD/PhD programs to offer full-time clinical experiences before the start of graduate school. However, some schools are choosing not to do this. The only way to find out what is being done is to ask, if it is not evident from the program’s Website.

HOW LONG DOES IT TAKE TO COMPLETE TRAINING AFTER GRADUATING FROM AN MD/PHD PROGRAM?

Corny as this may sound, the process is never really finished. Your education will continue throughout your career. A more pragmatic answer is that training will extend beyond medical school and graduate school as you complete your post graduate education. Here are some typical numbers: MD/PhD program, 8 years. Residency, 3–6 years. Postdoctoral fellowship, 3–6 years. For most people the term “postdoctoral fellowship” includes another year or two of clinical training, followed by a return to research for 2 or more years (Figure 1). For example, I completed an MD/PhD program in 6 years, followed by a residency in internal medicine (3 years) and a fellowship in clinical hematology and oncology that was combined with postdoctoral training back in a lab (3 years). After that I became an assistant professor and started my own lab. That timing was fairly typical when I did it. Now it would be considered fast. On the other hand, my job description when I finished included running a research team, looking after postdocs and graduate students, and taking care of sick people with complicated medical problems, so maybe all of that training time was necessary.

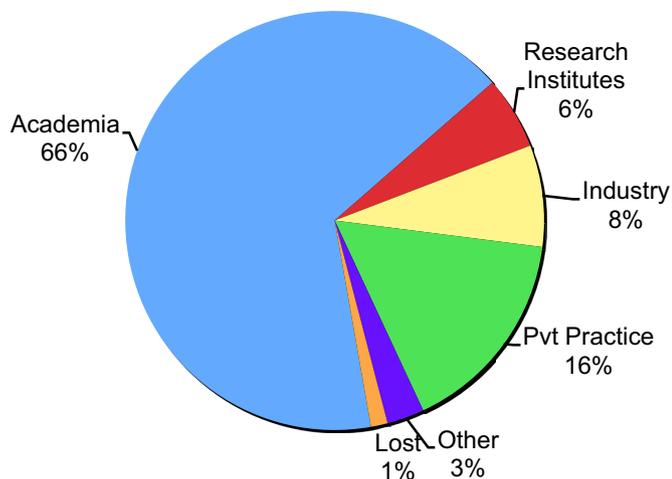


FIGURE 2: Where are they working? Data from 2202 MD/PhD program alumni who have completed all phases of postgraduate clinical and research training. Adapted from Brass *et al.* (2010). Industry includes the biotech and pharmaceutical industries. Pvt Practice refers to full-time clinical practice outside of an academic medical center.

WHAT HAPPENS TO THE GRADUATES OF MD/PHD PROGRAMS?

Short-term, nearly all do additional clinical training. Those who do not are usually headed toward careers at research institutes or outside clinical medicine entirely. Those who do apply for residencies often find that their MD/PhD training makes them particularly appealing to residency programs at top institutions. Long-term, most program graduates end up with careers in which they combine patient care and research. The research may be lab-based, translational, or clinical. Most (75–80%) end up at academic medical centers, at research institutions such as the NIH, or in the pharmaceutical/biotech industry (Figure 2; Brass *et al.*, 2010; Akabas *et al.*, 2018). A much higher percentage of MD/PhD program graduates have ended up in academia than of medical school graduates in general (Brass *et al.*, 2010). Those who build research careers and apply for NIH research grants find that having the PhD in addition to the MD improves their chances of obtaining funding (Ginsburg *et al.*, 2014).

HOW DO I APPLY?

The process of application varies from school to school. Some schools have an MD/PhD-focused committee that will screen your application and coordinate the interview and admission process. Other schools consider MD/PhD applicants only after a decision has been made about MD admissions. Finally, some schools consider students for the MD/PhD program only after they have completed a year or more of medical school. Schools that subscribe to AMCAS will ask you to indicate your interest in an MD/PhD program and then to provide additional information as part of a secondary application.

WHEN DO I APPLY?

Most people apply after finishing their junior year in college, but a growing number of applicants finish college and work for a year or more before applying. Some people use the time after college to take courses needed for medical school admission or to gain more full-time laboratory research experience. Some people simply were

not ready to make decisions about their future careers and postponed choosing beyond the finish of college. It is a mistake to assume that MD/PhD programs are interested only in applicants who have worked in a lab for a year or more after college. That is clearly not the case, and some of us who direct MD/PhD programs are concerned about the growing percentage of applicants who have waited to apply after they graduate in the mistaken impression that it will improve their resumes. My advice is that for a training path that lasts as long as this one does, it is best to get started as soon as possible.

WHAT DO ADMISSIONS COMMITTEES LOOK FOR?

The answer clearly varies from school to school, but some basic principles apply. In general, admissions committees will look for evidence of academic success, extended research experience, letters of recommendation from people who know you well, and your plans for the future.

1. Evidence of academic success. This includes your GPA and MCAT scores, but is not limited to them. Admission committees use a holistic approach and will undoubtedly consider where you went to college and what types of courses you took. They will not necessarily be dismayed if you got off to a slow start, as long as you did well later. They will place the greatest emphasis on courses that are relevant to your chosen area of graduate school training. I have not encountered a program director who seriously believed that the MCAT tests your ability to be a physician–scientist. Nonetheless programs use MCAT scores in a variety of ways, including seeing how you compare with the national pool of applicants and predicting how you will do on the numerous standardized tests that all of us have to take in medical school and beyond.
2. Extensive research experience. If you plan to get a PhD in one of the laboratory sciences, then prior laboratory experience counts heavily, particularly if you spent a year or more in the same laboratory. Summer laboratory experience can be helpful because they are usually opportunities to do research full time, but summers are short. Whenever possible, you should try to do research during the academic year, or at least spend multiple summers in the same lab. If you are planning a PhD outside of the laboratory sciences, seek equivalent experiences. The idea is to be sure you like the experience and to create a track record upon which your past performance can be judged and your future success predicted.
3. Letters of recommendation. The most important letter(s) are from the faculty members or other senior investigators with whom you worked. The letters should ideally comment on your talents, skills, and potential for success as an independent investigator. If you are working with a senior faculty member, it is very helpful if he or she can compare you with other students with whom he or she has worked. Note that such a letter is not necessarily the most appropriate for an MD-only application. MD/PhD program admissions committees are usually most interested in your talent and ability as a physician–scientist, although they will definitely also consider whether you are likely to become a successful and caring physician. Fortunately, medical schools allow you to submit more than one letter of recommendation.
4. Your plans for the future. Because training to be a physician–investigator is so costly in terms of your time and the school’s resources, your career goals should be compatible with MD/PhD

training. Becoming a full-time practitioner is a laudable goal, but does not require a PhD in addition to an MD. Your goal as a trained physician–investigator should be to spend at least 75% of your time on research. You do not need to know the specific problem you want to work on at this point (many do not, and it is likely to change), or with whom you would like to train, but your commitment to becoming an investigator should be clearly communicated in your essays and interviews, and you should have given thought to what will be required.

HOW DO I DECIDE WHERE TO APPLY?

Some applicants have decided that they want to work in a particular field or with a particular faculty member. For them, choosing where to apply is defined by where that faculty member works or where the field is best represented. Most applicants have only a general idea of what they might want to work on in the future and know that their interests are likely to evolve as they are exposed to new things. For them, choice will be defined by issues such as the reputation of the school (hopefully not based solely on *U.S. News and World Report* rankings!), the success of the graduates of the program (be sure to ask!), and geography. Schools vary in the difficulty of gaining admission. The directors and nonfaculty administrators of MD/PhD programs nationwide are a large pool of resources that you can tap. Most of us get e-mail from future applicants all the time. Take advantage of our willingness to talk with you. Ask questions about the things that are important to you.

FINAL THOUGHTS

I began this perspective with the confession that I am a physician–scientist and I like what I do. It is not unusual these days to encounter articles and opinion pieces that lament the difficulty of becoming and remaining a physician–scientist. I will not cite them here—you can find them on your own. Fortunately, our society is still willing to make a large investment in biomedical research through the NIH and through numerous foundations. If you want to become a physician who discovers the new stuff, there are jobs waiting to be filled. However, you will need good training and great mentorship as you learn the skills needed to be a physician and a research team leader. Good luck with your decision.

ACKNOWLEDGMENTS

My thanks to my colleagues who direct MD/PhD programs, the NIH for supporting physician–scientist training (including my own), and the hundreds of MD/PhD candidates and alumni who have taught me so much over the past 20 years.

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