# How to Pick a Graduate Advisor

Ben A. Barres[1,*]
[1]Stanford University School of Medicine, Department of Neurobiology, Fairchild Building Room D235, 299 Campus Drive, Stanford, CA 94305-5125, USA
*Correspondence: barres@stanford.edu
http://dx.doi.org/10.1016/j.neuron.2013.10.005

**In this NeuroView, I provide a guide for young scientists on how to select a graduate advisor or postdoctoral advisor. Good mentorship is not only pivotal for career success, but it is pivotal for driving innovation and for the health of our universities. Universities need to do much more to teach faculty how to mentor and to ensure mentoring quality. I propose an M-index to measure mentoring quality. I also call here for better studies of what great mentorship entails, better reward for great mentors, and more consideration of mentoring quality when awarding prizes and grants.**

## Introduction

When I was a student, I often imagined what fun it would be to someday have my own lab. There I would be able to follow my curiosity, studying whatever questions happened to interest me. By great good fortune, this dream was fulfilled and I have been able to study the mysterious roles of glial cells in health and disease in my own lab at Stanford for the past 20 years. I cannot tell you how rewarding this quest has been and how incredibly lucky I feel to have had this opportunity. I never imagined as a student, however, that it would be just as much fun and just as rewarding to mentor students as to do experiments myself. It has been a tremendous privilege to mentor so many talented graduate students and postdoctoral fellows. But it seems to me that we don't talk a lot about what being a great mentor entails. That's what I'd like to talk about here. What is a good mentor and how can you find one?

As a student, I loved to read books with advice to young scientists (Ramón y Cajal, 1897; Medawar, 1979). These wonderful books focused on how to do excellent science but did not talk much, if at all, about the importance of selecting an excellent mentor. The importance of mentorship has sometimes been written about (Kanige, 1993; Lee et al., 2007), though this did not occur to me when I was young. Now that I am older, I often reflect on my good fortune to have been one of the half of the entering students in my PhD class at Harvard who was successful in science. I now realize that all of us selected our graduate mentors amateurishly, almost randomly, and certainly not wisely. Through sheer dumb luck, I happened to pick a wonderful mentor. It is in that spirit that I write this guide about how to pick a graduate advisor. It is the guide that I wish someone had handed to me the day I entered graduate school. I write this with some trepidation, as I am certainly not a Nobel Laureate as were Medawar and Ramón y Cajal. But, as I always tell my students, the real Prize is enjoying doing science. This is a Prize that I have won. I want my students—and every aspiring young scientist—to win it too.

So why do some talented students succeed as scientists whereas others do not? This is a question that has long intrigued me. I see it around me every day. Students who have always loved science from a young age enter graduate school, but some of these students leave not enabled to be a successful scientist and/or demoralized, having somehow lost their passion for science. I will argue here that for most students, selecting a good research mentor is the key. To be sure, many students realize in graduate school that another career choice appeals more to them and happily divert to a new goal. But here I address my comments to the large group of graduate students whose goal is to be a successful researcher, whether in academia or in industry or another setting.

First, let me mention what a student should never ever do. An advisor should not be selected solely because he or she is the one researcher at your university that happens to work on the precise focused topic that you think you are most interested in (usually whatever you worked on in an undergraduate lab). In my experience, this is exactly what nearly every graduate student does! Keep in mind that if you like solving puzzles, as all scientists do, there will be many different puzzles that you will find equally rewarding to work on. Although I study the brain, I am certain that I would be just as happy working on the kidney (some would argue that glia are the kidneys of the brain). Begin your search for an advisor by casting as broad of a net as possible. Neuroscience these days spans many areas from molecular, cellular, and developmental neurobiology, to physiology and biophysics, to systems, behavioral, and computational neurobiology. Try lab rotations in different areas, which is increasingly important in an interdisciplinary world. So as your first step in finding a good mentor, create a list of possible advisors in your general field of interest, broadly defined rather than focused on a highly specific research topic.

If not based on exact research topic, then how else can one select a good mentor? There are only two criteria of any importance: scientific ability and mentorship ability. If your advisor does not know how to be a good scientist or does not know how to train you to be a good scientist, you are unlikely to become a good scientist. Perhaps I would add passion for science to that list as well. I was lucky enough to be an undergraduate at MIT (back in the good old days when they selected 50% of applicants). It has been 37 years since I graduated, and I have long forgotten all of thermodynamics, physics, calculus, and almost everything else they taught me. What remains are memories of the incredible passion for science that nearly all of my professors exuded, including that of Professor Hans Lukas-Teuber, whose powerful course diverted me from my interests in chemistry and computer science to neurobiology and medicine.

## Pick an Advisor Who Is a Good Scientist

First, how can you identify advisors who are good scientists? Okay, here is where I am going to start to get into some touchy opinions, and no doubt this is why practical advice articles are rare to come by. But let me proceed with honesty into a field of land mines. First and very importantly, never assume just because a faculty member has a job at a good university that he or she is therefore a good scientist. For one thing, many faculty members that appeal most to young graduate students are assistant professors. That is, they do not have tenure yet and only some of them will make it to tenure. As I will discuss later, however, young faculty are often superb choices for graduate mentors. Second, many faculty are not tenure track. This does not mean that they are not good scientists, but it does add to the risk. Third, some faculty who are not good scientists make it to tenure anyway. Tenure is by no means a perfect process, and there are good scientists who are not tenured and vice versa. Fortunately, every single university has many great scientists who are also great mentors. Your job is to pick one of them.

So how can you, a mere first year graduate student, possibly decide which advisors are good scientists? After all, the whole point of earning a PhD is to learn the difference between good and bad science and you haven't learned how to do that yet! Fortunately, there are some simple things that a first year graduate student can and should do. The hallmark of a good scientist is generally that he or she asks important questions and makes mechanistic or conceptual steps forward in answering them. Because most students are not yet prepared at the start of their PhD study to evaluate the quality of a scientist's research, a simple thing that a student can do is a PubMed search and make sure that their potential advisor is publishing research papers in good to top journals. Even though you are just beginning your training, you should read some of these papers to see if they are well written, rigorous, and interesting to you. Care should be taken to distinguish research papers from reviews, which although important are not signs by themselves of research accomplishment. Although quality of the research papers is paramount, number is also important, keeping in mind that large labs should obviously be publishing more papers per year than a small lab, so some normalization for that factor is important. If your prospective advisor has not published a good research paper in over 5 years, this is a serious warning sign (what is the chance you will just happen to be the one student in that lab to publish?).

Another measure of the overall productivity and impact of a scientist's work as a whole is known as the H-index, which is a single number that rates a scientist's most cited papers and the number of citations that they have received (http://en.wikipedia.org/wiki/H-index). Any scientist's H-index can be found at the Web of Science (http://thomsonreuters.com/web-of-science). Keep in mind that older scientists will have higher H-indexes than younger scientists. Second, a student can learn much about a potential advisor's research productivity and accomplishments by simply reading the advisor's curriculum vitae. You should not be shy to ask for a prospective advisor's CV. This does not reflect poorly on you but rather shows unusual maturity and that you are being careful about how you select your thesis advisor. In some cases, the candidate advisor may be a Nobel Laureate, National Academy member, HHMI investigator, or have won some other distinguished scientific award or prize, such as an NIH Pioneer Award, which is generally an excellent sign that they are a good scientist. Most good scientists, however, lack these awards and this should not be considered a negative factor. Indeed, working with a young faculty member who is skilled in the latest techniques, still has a small lab, and therefore much time to mentor you, can often be an excellent choice.

Another objective measure of the quality of science a lab is doing is whether they have established National Institutes of Health (NIH) (or other) grant support. If this information is not listed on his or her CV, it can easily be checked by going to the NIH grant database (http://www.report.nih.gov). Unless your prospective advisor is in his first several years of starting his or her own lab, lack of NIH support in the form of one or more R01 grants would be a sign that he or she has not been sufficiently productive to merit further support. That said, without doubt obtaining grant funding is highly competitive these days, and this means that many good scientists may sometimes fail to obtain or renew a highly deserving grant application. Nonetheless, it is important for your training that you select an advisor who has sufficient funds to support your graduate research.

When in doubt, a very important source of helpful information is to ask senior faculty, such as your graduate program advisor or your undergraduate thesis advisor, for their candid thoughts about particular faculty members of interest. A student would do well to listen carefully to the responses, as a senior faculty member is unlikely to torch another faculty member (after all, they have to work with them for the rest of their careers) but might make gentle comments meant to steer you away from one candidate in favor of others.

Doing all this research to select a good advisor may seem over the top, but as selecting a good advisor is one of the most important factors in determining whether you will be successful in your career, I think it goes without saying that you should carefully research what lab you will train in at least as thoroughly as you research what cell phone or car to buy (or in my case what espresso machine).

## Pick an Advisor Who Is Also a Good Mentor

Selecting an advisor based on scientific abilities alone is not sufficient. Having narrowed your list of potential advisors to those that are good scientists, next you must determine which are also good mentors. One of the most important tasks of an advisor is to help his or her student to formulate a good and tractable question and then to gently guide a student to formulate good experiments to address this question while encouraging the student to be increasingly independent over time. A good mentor does not put his student on a scientifically trivial question. If a student does not address an important question and take it a step forward during their thesis or fellowship years, they will not have the confidence that they can do this in their own lab, and likely they never will.

Good mentors spend enormous amounts of time with each of their students discussing science, how to design good experiments and interpret and analyze data, how to write research papers and grants, how to review papers for journals, practicing talks, and providing career guidance. They also allow and encourage their trainees to take time away from their research to do other activities that will enhance their training such as TAing graduate courses, attending conferences, and taking special summer courses. Sometimes trainees will need some time away from lab for parental leave. A good mentor will be supportive of this for male as well as female trainees; a few months away are irrelevant in the lifetime of a typical multiyear project.

So how can a student tell whether a prospective advisor is a good mentor? First, talk with some of his or her current and previous trainees. Ask them whether this faculty member is a good mentor in terms of spending sufficient time with each student. Ask these trainees whether they enjoyed being in that lab, and especially whether there is a team spirit in the lab, with everyone helping each other rather than being pitted against each other. Are lab meetings group discussions in which everyone contributes their thoughts and ideas, or is it primarily a time where the faculty member dictates to presenters what they should do next? (Helpful suggestions are one thing; micromanagement is another.) Second, determine what percentage of trainees in the lab are postdocs versus graduate and undergraduate students. A lab that is nearly all postdoctoral fellows may suggest that the lab head does not enjoy, or wishes to minimize, time spent mentoring. Good mentoring takes much time and devotion. Therefore, graduate students should be very cautious about selecting unusually large labs. Your lab rotation will give you an additional chance to assess all these questions.

Lastly, and most importantly, it is critical that you determine the faculty member's track record of mentoring success. One way to begin to address this question is to obtain a copy of his or her "trainees list" (this will of course not be helpful in vetting junior faculty who do not yet have a long track record of training). This trainees list, which is required to be submitted for each faculty participating in an NIH training grant, is a simple list of all of the graduate students and postdoctoral fellows a faculty member has ever had and what job they are doing today. Asking potential advisors for their trainees list might be a tad awkward, so graduate program offices should keep up-to-date copies of these lists on file for their students, and I believe that the information contained in these trainees lists is so important that the NIH should post this information electronically in a publically accessible database. It is not uncommon when looking at trainees lists for all of the faculty in the same department or program to find widely varying "success" rates, with some mentors having 70% of their students attain academic positions and others sometimes only 10% or even fewer. Not every student ends up having their own lab, whether because of choice or ability, and so even the very best advisors rarely have more than 50% of their graduates going on to have their own labs. But if only a very small percentage of trainees go on to have their own labs (whether in academia, industry, or government), this is a warning sign that little successful mentoring is happening. Some scientists are simply better mentors than others (just as some models of cars and espresso machines are better than others). Some don't enjoy mentoring, some don't want to be bothered, and some plain don't know how. The output of a truly great lab is not measured only in Nobel prizes and research articles but just as importantly in how many successful scientists it trains. I certainly do not mean to discount in any way the value and importance of training young scientists to go into other excellent science careers including teaching, science writing, scientific journals, consulting, etc. In any case, quality mentoring will of course greatly enable your performance in all of these alternative careers as well.

I have previously written about the challenges that talented women still all too often face in their careers (Barres, 2006). Sometimes, female graduate students preferentially seek out female graduate advisors in order to obtain a role model for how to balance career and family. While this is understandable, increasingly male faculty also serve as important role models for work-life balance. I would strongly suggest to women students that as they evaluate potential graduate advisors, male or female, they examine to what extent prospective mentors have a good track record of having trained successful women scientists.

As you gauge the mentoring environment of a prospective lab, make sure to ask whether the students are generally happy. If not, this is a warning sign. I strongly believe that when a talented student is in the right lab, with a good mentor, that going to lab every day should feel almost like being in summer camp. Someone once told me with great sincerity that he felt that you had not done a real PhD until you hated your advisor and he or she hated you. This is a tragic way of thinking! I have heard of many cases in which a student has been told that they are not working long enough hours in a lab and that the advisor expects the student to work 60+ hours per week. In 20 years, I have never said or implied such a thing to any student. I feel that the advisor's job is to provide a fun and exciting environment, to set a good example, and the rest must come from the heart of a student. Henry Ford once said, "Hire good people, and then get the hell out of their way." What great advice! If all is well, doing science will feel like play, and students will freely choose to work long hours because it is fun and exciting (that does not mean there will be frustrating times when your experiments are not working, of course). Moreover, if trained well, there should be no problem being successful in science while leading a happy and balanced life (okay, I am not a great example of this—but most of my previous students have accomplished a balanced life in their own labs despite my poor example. And I am living the life I love, just as I hope for my students.)

Here are some signs that a prospective advisor is thinking more about his own career and less about your career: he (or she) never mentions his students' names when he presents their work in a talk or only mentions them in a long list in small print at the end of the talk, he does not practice the students' talks with them, he puts two students in the lab on the same project so that they must compete with each other, he tells you what experiments you must do, he insists on writing the research papers rather than allowing the student to write it and then editing it with the student, he allows the students' papers to sit on his desk (sometimes for years, sometimes never even submitting them), and he refuses to allow students to take their projects or reagents with them (or fails to make sure they have lots of good starting points for projects in their own labs). Although most faculty do not behave this way, I have seen these things happen to many students over the years. Most students who fall victim to these kinds of harmful, selfish practices do not survive in science as a result. This is among the reasons why I believe it is vital that measures be taken to better identify great mentors and to reward scientists as much for mentoring ability as for scientific accomplishments.

If the day arrives when you are in graduate school when you wake up and do not wish to jump out of bed and head off to lab, it is time to consider whether it is time to switch to another lab. I have encountered many students who realized midway during their PhD that they were not happy in their lab, only to decide to stick it out rather than discuss the situation with their advisors and try to resolve the problem. My advice is to have a heart-to-heart chat with your advisor, giving him or her a chance to help you resolve the issue. If your advisor is not sympathetic, then it is time for you to switch to another lab. If you cannot find a lab that you are happy in, then it is possible that science is not the right career for you. But all too often, the problem is simply poor mentoring or a mismatched lab for whatever reason. I have seen all too many students feel that they must please their advisors and complete their projects. But always remember that your PhD training is about YOU and your success. Most productivity occurs in the last 1 or 2 years of a PhD thesis and usually switching to a new lab, even after a few years in the wrong lab, does not delay a student's graduation. Just think of your time in the first lab as a long rotation that beneficially added to your training.

Once you have selected a great lab, it is time to get to work. How to be successful in that lab is the subject of another essay. But I would advise you to remember a few things. First, do pick an important question but don't pick the same topic that everyone else is working on. It will be more fun and less competitive to go your own way. For every trendy topic now, there are 100 other topics just as important and hardly studied yet. Second, there is no need to write more than one paper; just make it a good one. It probably will take you about 6 years (counting course work). If you can work on an important question as a PhD student (or postdoc) and take it a step forward, you will have the confidence and enthusiasm to do this for the rest of your life. And students, please, do not skip your postdoctoral fellowship no matter how successful your PhD thesis work has been. It seems to be all the rage these days to shorten training time. NIH is even providing special fellowships for those who want to move directly to independent positions after their PhD training. But I have noticed that people who skip their postdoc may do okay in their own labs, but they generally fail to broaden as scientists or to achieve the versatility and fearlessness to enter new fields that they might otherwise have achieved. That is a large price to pay for skipping what could otherwise be a marvelously fun and rewarding final period of training.

## Some Challenges of Mentorship and the Path Forward

Anyone who has had a lab knows that by having great trainees with diverse backgrounds and perspectives immersed in an environment of genuine respect for their thoughts, creative new ideas are constantly bubbling forth in lab discussions—ideas that the lab head would never have had by himself or herself. I have heard scientists talk about the pleasure of scientific discovery—that moment when you know something amazing that no one else in the world knows. But there is no moment more mind blowing to me than when one of my students makes the leap to thinking like a real scientist.

Mentorship is a tremendous responsibility. Great mentorship does not end when a student leaves the lab. For instance, a good mentor must make sure the student selects a good next lab or job (and not compete with him on the same set of experiments), allow him to take his project, reagents, and mice with him, write strong letters of recommendation for fellowship applications and jobs, suggest his previous students as speakers for meetings and authoring review articles, and he should actively credit his student fairly for his accomplishments when giving seminars and bring his student's name to the attention of appropriate job searches. A great mentor is very generous and gives till it hurts.

I am concerned that as competition for funding increases in science, some good mentoring practices will increasingly be put into jeopardy. In the rush to make sure that they are successful in renewing their grant funding, lab heads may commit the cardinal sin of becoming micromanagers, dictating to their students exactly what experiments to do. Young scientists who are not allowed to be independent as students and fellows are generally not able to successfully achieve this in their own labs. Often these days, talented young scientists observe the stress that their highly accomplished PhD advisors experience after a failed grant application and become concerned, quite reasonably, that they will not be able to successfully compete for grants when they have their own labs. It is fortunate that NIH has put measures into place to make sure that a fair percentage of young scientists get funded.

It's a tremendous art to keep a lab highly productive while at the same time optimally nurturing one's trainees. How can we better recognize who the great mentors actually are? The H-index is an established tool for quickly evaluating a scientist's impact. To be sure, it is not perfect, but it is simple and widely felt to be pretty good. I propose that we consider developing an M-index to provide a similar measure of mentoring ability. The M-index would simply consist of an average of the H-indexes of a given scientist's mentees, that is of their average scientific productivity and impact. Because both H- and M-indexes become more meaningful later in a career, they would not be helpful in evaluating young scientists. The M-index could be calculated from data already on PubMed by including only first authors of the mentor's papers in the analysis and assuming that these first authors are the graduate students and postdocs. Because excellent mentors often beget scientists who themselves are excellent mentors, when evaluating a young scientist, it would make sense to take a look at the M-indexes of his or her mentors.

But identifying great mentors is only a first step. Whenever I meet a great mentor, I always ask them what they do that has the highest training impact. I rarely get the same answer, yet everyone thinks they know what matters. I have made some guesses in this essay, but data are lacking. We need to investigate what practices great mentors have that have the most impact in training successful young scientists. Recently, it has been increasingly realized that the teaching ability of K–12 public school teachers varies dramatically. The Gates Foundation funded the "Measures of Effective Teaching (MET)" project, designed to determine how to best identify and promote great teaching. The project demonstrated that it is possible to identify great teaching by combining classroom observations, student surveys, and student achievement gains (http://www.gatesfoundation.org/media-center/press-releases/2013/01/measures-of-effective-teaching-project-releases-final-research-report). They are now doing detailed studies to identify what practices underlie the most effective teaching. Perhaps academic science should do the same to understand what great mentorship consists of. Then we could start to actually teach this to our students.

I have argued that the greatness of a university may well depend on high quality of mentoring; happy and well-mentored trainees to a large extent drive great innovation. Effective mentoring should be an expectation that is not only talked about but actually ensured. Universities have an obligation to better track the experiences of trainees in each laboratory, so that pertinent data can be collected (in a confidential system that protects trainees' careers). I suspect that some mentors might well be surprised to learn that their trainees are unhappy and would be grateful for and responsive to any feedback. If, despite counseling, a faculty member continues to routinely take advantage of their graduate students, harass them, or fail to mentor them effectively, then I strongly believe that privilege should be revoked.

Once we can identify great mentorship, we should much better reward it. This is more important than ever. When awarding prizes, let us not consider only those who made a great discovery but rather those who made a great discovery while at the same time effectively mentoring their students. Doing great science should be necessary but not sufficient. The honor of top prizes can only be enhanced by giving them to great scientists who are also great human beings. Honoring one's commitment to our young, and treating them generously and fairly, is an important sign of our integrity as scientists. So let's create more awards for great mentoring. And let's take mentoring effectiveness into consideration, when considering promotions and even in awarding NIH grants. After all, much of NIH grant funding is used to support the salaries of trainees to create the next generation of scientists. If we do all this, then we will be affirming as a community that quality mentorship really matters and is vital to the sustained success of science.

## ACKNOWLEDGMENTS

B.A.B. gratefully acknowledges that he was most fortunate to have had the world's very best mentors for his graduate and postdoctoral training: David P. Corey and Martin C. Raff. David and Martin spent countless hours training and advising me, allowed me to be as independent as possible, providing gentle guidance when needed, always exhibited the highest integrity, and both helped me to love science even more than I ever imagined possible. Many thanks also to my current and previous trainees for their many helpful comments on this manuscript.

## REFERENCES

Barres, B.A. (2006). Nature *442*, 133–136.

Kanige, R. (1993). Apprentice to Genius: The Making of a Scientific Dynasty Paperback. (Baltimore: Johns Hopkins University Press), p. 304.

Lee, A., Dennis, C., and Campbell, P. (2007). Nature *447*, 791–797.

Medawar, P.B. (1979). Advice to a Young Scientist. (New York: Harper Collins Publishers), p. 132.

Ramón y Cajal, S. (1897). Advice for a Young Investigator. (Cambridge: MIT Press), p. 176.