

CAREER TRENDS

Step by Step:
Your Career from
Undergrad to Postdoc



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Introduction

A lot of what's written about science careers focuses on the career options available to individuals or how to apply for jobs when you're ready to go on the market. The reality, of course, is that we should be thinking about our careers long before that point. It is important to be strategic about the decisions that you make through your undergraduate education, graduate education, and postdoc in order to move your career forward in whatever direction you choose.

This booklet looks at the steps you can take throughout your training to better prepare for your career. Whether you're considering what internship opportunity to pursue, what sort of graduate school experience you might be interested in, or what realistic expectations might be for a postdoc, there's information here for you.

One of the themes that you'll find in this book is that it's important to figure out what your career goals are and carefully examine opportunities to determine whether or not they'll help to move you closer to these goals. Being a well-informed consumer is important not just when we're talking about buying a computer or a car, but also in making decisions about your training. Taking a pro-active approach to your career, like that described in the articles in this booklet, will help you set out on a path to success.

Once you're done reading this booklet, visit ScienceCareers.org. On our website, you'll find more articles as well as social networking communities, a forum, and a series of webinars that can help you to make the most of your scientific training.

Brianna Blaser, Ph.D.
Project Director, Outreach
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Making Your Summer Research Internship a Good One

By Elisabeth Pain—December 12, 2008

Howard University biology student **Chinweike Okegbe** spent this past summer at the Massachusetts Institute of Technology in Cambridge investigating how bacteria communicate as part of the MIT Summer Research Program in the Biological Sciences and Related Fields. According to **Lars Dietrich**, the MIT postdoc who supervised him, Okegbe's first two weeks were a struggle. A lot of experiments didn't work and "at the very beginning he was very frustrated about it." But "then it clicked. He really understood how to do research."

Getting past the frustration—and in the process learning how real research differs from science learned in the classroom—is what undergraduate research internships are all about. Yet despite the focus on real research, real progress in most programs is regarded as a bonus and not the main objective. Okegbe went on to produce some interesting results and to contribute intellectually to a research paper Dietrich plans to publish. "What I really wanted him to understand is that this is how science works," Dietrich says.

What's expected during an internship

At the core of most summer research internships is a research project of your own. While working on it, you learn new scientific techniques and how to design experiments, analyze results, formulate hypotheses, and keep a lab notebook. In the best cases (but not always), you work closely with a supervisor who guides and inspires you.

Undergraduate interns are expected to work hard to learn the field well enough to understand the key questions and motivations. They "need to learn about background literature and understand what's going on and why they are doing things," says **Omar Janneh**, a lecturer in pharmacology at the University of Ulster in Coleraine, United Kingdom. They must be "able to ask questions and understand why they are doing things and not just following protocols."

Interns are expected to attend lab meetings, symposia, and sometimes classroom lectures. And don't expect that you'll be sitting in the back row every week: Sometimes you'll be demonstrating your own scientific insight and developing your science communication skills.

Obtaining interesting scientific results in just a few weeks—most summer internships last for 10 or 12 weeks maximum—isn't likely, and it's usually not the point, Dietrich says. It "is more about experience than output, and we don't expect the students to produce papers for a journal within 10 weeks," says **Jonathan Williams**, an associate professor at the Institute for Astronomy at the University of Hawaii, Honolulu, who runs the Research Experiences for Undergraduates program there.

"Don't only do what your adviser tells you but also use your own creativity and your own mind."



Perhaps the most important thing an intern can do is attack scientific challenges with enthusiasm and seriousness. A good summer intern is "absolutely keen on the job and is a good listener and is ready to learn and contribute to whatever is going on in the lab," Janneh says. He or she is also "somebody who is able to work with a team but also be an individual contributor."

Real Research

A first difficulty for some interns is revising their expectations about the kind of work they'll be doing. "Some summer students come here with a much purer view of what research is than what it actually turns out to be. Much of what people do here is really very dirty work like getting down on your knees, pulling cables, ... working long hours, just sitting around waiting for the beam to come back on," says **Michael Doser**, a physicist at the European Organization for Nuclear Research near Geneva, Switzerland, who helps run a Summer Student



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Programme there. Some undergrads also expect to spend most of their time using the lab's expensive equipment, when in fact, in a field such as astronomy, “the data is so complex that one or two nights of data will keep them busy for the entire summer,” Williams says.

Most first-time researchers encounter a gap between the work they're doing and what they learned in their courses. Although most class assignments often require you to find predefined answers, research questions are open-ended. Interns should be prepared to see many of their experiments fail—and to learn from each failure.

Another expectation summer researchers may have to revise is how much time supervisors will spend with them. Some students “think they are going to see the mentors every day.” But “mentors are pretty busy people, and they will give them a few hours a week,” Williams says. So interns must learn to work independently.

Doing well

Trust is paramount in science, so you need to approach your work with rigor and integrity. Think through your approach and carefully consider every step. “You want to think about doing your experiments and making them fail-proof and really present some convincing evidence that what you are saying is actually true,” Okegbe says. “You have to maintain a clear mind and look at data and look at questions objectively and try to solve them without being biased toward any particular solution.”

Once the data start coming in, make sure you keep a good lab notebook, because a reliable scientific record is another cornerstone of science. In any laboratory, a good lab notebook makes the data completely clear and provides enough information about your experimental technique to allow another trained scientist to reproduce your work, even years from now. It's important to understand the system of documentation your lab uses, because every system has idiosyncrasies. One big surprise that some interns encounter is that some labs don't have a good system of keeping records. If you find yourself in such a laboratory, raise the standard.

Ask questions, and lots of them, but start by asking them of yourself. Get used to finding your own answers, from books, scientific journal articles, and laboratory colleagues. “The best students ... will be told how to do something, and they will go away and do it, and they'll come back and show you their results,”

Williams says. “If there is an unexpected problem, they try to figure out what's going wrong themselves before immediately going to someone to get the answer,” he adds. “If they really are stuck, then they go for help.”

One great advantage of seeking your own answers is that sometimes the answers you come up with are new. “If I give different students a problem, some of them will solve it in a very straightforward manner to my complete satisfaction, ... but it will be what I expected,” Doser says. “And then occasionally somebody will ... come up with an idea that I've never heard of ... and will give a new development to a certain problem,” he adds. “Don't only do what your adviser tells you but also use your own creativity and your own mind,” Dietrich says.

It's one thing to be asked to work independently; it's another to spend the whole summer at the sink washing glassware or floundering at the bench without insight or guidance. A summer internship is—or should be—an educational experience, so interns have a right to expect face time with advisers and a legitimate scientific challenge. If you have a problem, “try to talk to the supervisor,” Dietrich says. If that doesn't work, “I would advise to switch the project or ask if you could work with another supervisor.” And if that doesn't work, Dietrich says, just try to find someone in the lab who can help you.

Also a social experience

A good way to enhance your learning experience is to interact with people other than your supervisor. But don't limit your interactions to the laboratory. In many labs, planned and spontaneous social events are common. Undergraduates should participate in these events because “it gives you a better feel [for] how the people are in science, what you can do beyond the research,” Dietrich advises.

A summer internship should be a rich experience, in and out of the lab. Williams wants his summer students to enjoy Hawaii. “We expect them to go swimming, dive, travel to the other islands, climb, go hiking, ... but we also expect them to work hard when they're here. There's a time to work and there's a time to play, and they have to keep that balance.”

A summer internship can help you decide whether graduate school is right for you, and it can lead to important professional connections that can help you later. “Get to know your peers and those slightly ahead of you. ... Make friends and keep in touch,” Williams says. The road to a Ph.D., he adds, often begins with an internship, and “it's a long and sometimes lonely journey. But it's also exciting, and following different people at different stages of their career can be inspiring.”

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Professional Science Master's Degrees

By Diana Gitig—June 18, 2010

Michael Teitelbaum, a program director at the Alfred P. Sloan Foundation, could not agree more. That is why the Sloan Foundation decided to fund the first Professional Science Master's (PSM) degree in 1997.

Teitelbaum noted that certain scientific fields, such as geology, environmental sciences, and of course engineering, still have high regard for Master's degrees. But he pointed out that “in other sciences, in the past half century the Master's degree has been relatively undervalued in favor of the Ph.D.”

Carol Lynch, director of Professional Master's Programs at the Council of Graduate Schools, elaborated on that idea. She added that “other countries really emphasize traditional thesis-based Master's degrees as a preview for a doctoral education—as a credential to demonstrate that an individual has the aptitude for a research degree.”

That is not the case here. Yet 80 percent of science and math majors do not go on to graduate work in their field; rather, most go into the work force. The Sloan Foundation perceived a gap between Bachelor's level math and science education and the level of expertise required by employers in industry. It created the PSM degree to provide a pathway for science and math majors directly into jobs, configuring it in response to employers' desires.

PSM curricula describe themselves as “science plus.” Typically 60–70 percent of their courses are science classes, usually the same classes that doctoral students take. The “plus” element consists of business classes. These stress project and business management, ethics, leadership, communication skills, and the ability to work in teams across disciplines. More specialized courses—for instance in government regulation or intellectual property—can be added depending on the field. These courses are heavily influenced by an employer advisory board comprising representatives from local industries who work very closely with the students. They can act as adjunct faculty members, give seminars, serve as mentors, and direct group projects. All students must also work in an internship, and the degree often culminates in a team project in lieu of a thesis.

In 2007, the National Science Foundation was authorized to establish a PSM initiative by the America COMPETES (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science) Act. In the American Recovery and Reinvestment Act of 2009—otherwise known as the stimulus bill—the NSF received \$15 million of federal funds to create more PSM programs and to improve those that already exist.

There are currently over 190 PSM programs at more than 90 universities; they are in 27 states and the District of Columbia. Roughly 2,500 students are enrolled annually, and there are about 2,700 graduates to date. The programs cover a diverse range of disciplines: mathematics, physics, biology, computational sciences, forensics, chemistry, and geographical information systems. According to **Stephen Lemire**, the former executive director of the National PSM Association (NPSMA), approximately half of PSM students are in the life sciences. The NPSMA completed its first alumni employment survey in August 2009. It revealed that graduates are in high demand by employers, with multiple job offers and a median salary of \$60,000–\$65,000 a year. When asked to report their salaries, 19 percent of those who responded checked “More than \$90,000 a year.”

A Niche for Every School

There are different types of PSM programs, appealing to different kinds of students. Certain schools target people fresh from their undergraduate degrees, who are seeking a tertiary education and training; others cater to professionals who are working full time but find they need specific abilities

Certain schools target people fresh from their undergraduate degrees, who are seeking a tertiary education and training; others cater to professionals who are working full time but find they need specific abilities to progress.



to progress. Programs are tailored accordingly. Lynch refers to a “PSM personality” as social and entrepreneurial, and Teitelbaum qualifies PSM students as risk takers, perhaps not surprisingly, as they opted to get a 10-year-old degree.

The Illinois Institute of Technology (IIT) was one of the first schools to establish a PSM program, in 1996. It was designed for working people looking to advance their careers. According to **Elizabeth Friedman**, its program director and the president of NPSMA, this evolved because one of IIT’s first faculty members, Walt Eisenberg, had been an analytical chemist in industry and knew very well that employees needed higher education—they were sorely lacking in business skills—but that they did not need independent research skills or the ability to write a thesis.

IIT began accommodating them by broadcasting their classes via satellite television so those who worked in local industries could attend classes remotely—they didn’t even have to leave their places of work. Since 1998 classes have been streamed live over the Internet. This online approach has been very successful and has been emulated by other schools. A notable example is the California State University system, which enrolls a lot of veterans. Of course, classes with a laboratory component must be attended on campus.

The University of Maryland University College, a primarily online institution, is popular with those in the active military to help ensure that they are qualified to pursue rewarding careers when they are done serving. Thus students are dispersed all over the globe. UMUC received a grant from the US Department of Education’s FIPSE (Fund for the Improvement of Postsecondary Education) program to set up online mentoring. After a year was spent establishing the online interaction platform, the first set of mentoring pairs was connected in the fall of 2009.

Students in their second or third semesters are introduced to mentors in industry, and they are required to meet once a month. But according to **Rana Khan**, director of biotechnology programs at UMUC, most of the 39 working pairs currently established meet once a week, sometimes by e-mail and sometimes over the phone. Khan said that “the most remarkable part is how generous the volunteer mentors are with their time. They tell their colleagues about it, and then their colleagues ask to join.” Another way that Khan recruits volunteer mentors in industry is through LinkedIn. Virtual internships are also available in UMUC’s five PSM programs. Other programs at UMUC are hoping to set up similar online mentoring programs by next fall.

Voices from the Field

Lakshmi Subbarao graduated from University of Delaware in 2004 with a bachelor of science in chemistry. In June 2006, she decided to enroll at IIT. The distance learning program allowed her to continue working full time while earning her degree. She graduated in December 2008 with a Master’s in chemistry. A month later, Subbarao accepted a position as an applications chemist

“the PSM movement is doing very well right now. We are seeing a lot of enthusiasm from faculty, student interest, support from industry and state government, and new support from the federal government.”



for Waters Corporation in Newark, Delaware. She attributes her career growth to the solid knowledge base obtained through the IIT PSM program.

Dmitry Royhman, currently studying to get his PSM in cell and molecular biology at IIT, says, “The reason I chose to do the PSM instead of the traditional Master’s degree was because the M.S. would have restricted me more toward research, and I was not sure that was the path for me.” Even so, he continues, “I chose to go to IIT because of their high emphasis on research. I started doing research here in a molecular biochemistry and biophysics lab, and I discovered that I really enjoyed doing it. Right now I am applying into the Ph.D. program here for molecular biochemistry and biophysics.” A number of PSM students in all of the fields find that, contrary to their initial misgivings, research is very much to their liking and they continue on to a Ph.D. program.

Rice University’s PSM program is focused on integrating the university with the surrounding community. It is perhaps not surprising then that the internship component of the program was the aspect that most appealed to the students there. **Danny Mills** got his PSM in environmental analysis and decision making from Rice. He notes, “I was especially drawn to the program because of the internship requirement, in lieu of a traditional research-based thesis, and the interdisciplinary nature of the degree. I was also attracted to the program because it stressed the importance of communications in addition to technical knowledge.” Mills is now a sustainability manager at the design firm HOK in Houston.

Shilpi Desai is currently a student in the same track. She says, “I chose to get a PSM because I was already working in the industry and I knew that a research degree would not suit my interests. I wanted to enroll in a program that was aimed at sending graduates to work in corporations, not colleges. I did not want to pursue a Master’s in business because my scientific aptitude was the one I wanted to further.” **Liang Ge** is currently studying subsurface geoscience at Rice. He says, “Compared with regular thesis Master’s or Ph.D. programs, PSM’s internship feature is the key reason I chose it. I am not very interested in academic research, so a Master’s degree is enough for me to begin my career in industry.”

The University of Connecticut has three PSM programs. About half of the students in its Applied Genomics track come straight from their undergraduate studies. Strausbaugh attributes this to the program’s very active outreach to other schools in the area. **Eric Carita** graduated in 2005 and, like Royhman from IIT, is now pursuing his Ph.D. Carita says, “The wide range of classes offered within the PSM program enabled me to gain the advanced education required by a variety of professional institutions. The internship I received at the Connecticut State Forensic Science Laboratory allowed me the opportunity

to witness how a professional laboratory functions, and gave me the experience required to gain a permanent position following graduation.”

Maria Bonatsakis, who got her PSM in applied genomics at U-Conn in 2009, says, “I knew I wanted to continue my education, but I wasn’t confident I could commit the time and effort for a Ph.D., so I decided on a Master’s program for starters. It has met every one of my expectations. I found a job immediately, and my group leaders at my company have praised the program as well.”

Kali Bogaard got her PSM from U-Conn in 2008 and worked for two years at Genomas, where she did her required internship. Then she decided to pursue a Ph.D. in human genetics at Baylor College of Medicine. Bogaard notes, “I was drawn to this program because I was not fully decided on what I wanted to do in the field, and the PSM program let me explore the many avenues that science can offer outside of academic research.”

Although the Internet-based, remote component of these programs has been growing, not all universities choose to follow that model. In 1997, the William M. Keck Foundation established the Keck Graduate Institute of Applied Life Sciences, an independent college within the Claremont Colleges in California. It has a Master of Bioscience program that, in contrast to many others, requires residence at the campus; classes are not available online. Its goal is to ensure that there is a pool of scientific talent that knows the commercialization process, as stated in promotional materials: “Students learn to catalyze development of basic life sciences research into useful new products, processes, and services.” Keck also introduced a unique Postdoctoral Professional Master’s in bioscience management to help scientists with Ph.D.s attain management and business skills.

Of course, not all students looking for a Master’s degree in the sciences need apply for a PSM; terminal Master’s degrees are still available. A Master of Science in biotechnology is popular at many schools, including The University of Pennsylvania, Johns Hopkins University, and Northwestern University.

Based on the pilot data from the NPSMA 2009 Alumni Employment Survey Report, the Sloan Foundation’s Teitelbaum was excited to report that “the PSM movement is doing very well right now. We are seeing a lot of enthusiasm from faculty, student interest, support from industry and state government, and new support from the federal government.” Carita’s words certainly confirm that sentiment, and are representative of many students’ feelings: “Without my PSM I would not have the career I do today; I would not be the scientist I am today; and I would not be the person I am today. I would highly recommend the PSM program to any student who dreams of one day working within any scientific field.”

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The selection of a doctoral program: it’s not quite marriage, but it’s a long-term commitment that could turn into a lifetime relationship, perhaps impacting—positively or negatively—the rest of your research career.

Finding a Partner for Your Ph.D.

By Emma Hitt—August 14, 2009

Most people graduating with their Ph.D. in science will say that graduate school represents a very different scenario than simply attending classes and passing exams, as during their undergraduate studies. A doctoral degree can sometimes take six or more years—and there’s no guarantee that the joyous day ending with a diploma in hand will even materialize. Unlike the undergraduate experience, earning a doctoral degree is largely dependent on one’s efforts to conduct research, write journal articles, and most important, complete a dissertation. Success in these areas arises at least in part from picking a graduate school and a program that represents a suitable match, selecting the right adviser, and perhaps experiencing a little luck with your research projects. On what basis, therefore, should a graduate school be selected? And how, exactly, can one sift through the myriad of potential matches to make this momentous decision?

The Right Match

According to data from the Ph.D. Completion Project conducted by the Council of Graduate Schools (CGS)—the main organization representing graduate institution deans in the United States—fewer than 60 percent of students entering graduate school in the sciences will complete their doctoral degree within a 10-year time frame. About one in five people in the life sciences drop out entirely during the

program. And by about year six, according to the project data, only about 42 percent of doctoral students in the life sciences will have completed their degree, 34 percent will still be slaving away at it, and 24 percent will have thrown in the towel. For the math and physical sciences, only about 39 percent complete their degree by year six, 27 percent are still going, and 34 percent have dropped out. These data underscore the need to pick a graduate school wisely.

“Completing a doctoral degree has much more to do with the right match of a graduate program to a given student than it does with personality characteristics or even the academic preparation of an individual student,” says **Debra W. Stewart**, president of the CGS. An excellent, motivated student may fail to succeed in a program that is not an appropriate match; whereas a less academically prepared student may blossom in the right environment.

One important aspect of the match has to do with academic climate, Stewart says. “Some students might do well in a kind of dog-eat-dog, highly competitive environment; other students would be crushed by that, and would do much better in a much more laid back, laissez faire-type environment,” she says. “You have to know yourself, and you have to really know the kind of climate you need to ensure that you grow and develop in your intellectual and professional life as a result of this program.”

Quality Counts

“We increasingly encourage students to gain information, including about placement of graduates of the program, how long it typically takes a student to get a degree, and what percentage of the students who begin programs actually complete them,” says Stewart. “All of those are dimensions of quality,” she says.

Above all, “the most important criteria for selecting a graduate school should be the quality and commitment of the faculty,” says **G. Steven Martin**, department chair of Molecular and Cell Biology, at the University of California, Berkeley. Factors to consider when evaluating the quality of the faculty include the number, impact, and significance of scientific publications, in addition to any honors and recognition received, he says. If a PubMed search on a potential academic adviser pulls up only a few publications in recent years, or if the publications are all in specialized or archival journals, then this may indicate that the faculty member has a limited interest in research, and perhaps spends more time as an administrator or in teaching activities. Likewise, if the faculty member’s institutional or lab website does not clearly describe the lab’s achievements or convey a sense of excitement about the research or future directions, then this, too, may indicate that selecting a more active lab might provide a more productive and satisfying graduate school experience.

An Interest in Interests

A key question with respect to match, also, is whether the faculty available at an institution meshes with a student’s particular research interests, Stewart says. “You can have a fine program across the board, but it might not have a sufficient

number of faculty members in a specialty area desired by the student.” Even within a specific scientific discipline, for example biology, the range of study—genetics, cell biology, botany, entomology, marine biology, zoology to name a few—can be very diverse. The same holds true for the physical sciences. Making sure a doctoral program can accommodate a student’s specific interest is an important first step in the selection process.

Resources

- Council of Graduate Schools. Resources for students. www.cgsnet.org/Default.aspx?tabid=160
- Gradschools.com. A comprehensive online graduate school guide to finding the best graduate schools and graduate degree programs. www.gradschools.com
- Petersons. A searchable database of graduate programs based on subject area, location, and other parameters. www.petersons.com
- PhDs.org. A website with extensive information on graduate school selection that lets students generate their own rankings. <http://graduate-school.phds.org>
- Science/AAAS Graduate Program Finder. <http://bit.ly/cot70Q>

For students with a clearly defined idea of what they want to study, perhaps the best resource will be a professor at an undergraduate institution who currently serves as an adviser or mentor. A student who has worked with a professor in a lab during undergraduate studies and wants more of the same may ask for a recommended professor or program of related research at another institution.

However, not all students have a clearly defined path when they go to graduate school, so one strategy for a successful match is to pick a larger school, with many different types of programs and qualified faculty. “The interests of students often develop and change between undergraduate and graduate studies because the student is exposed to many more research options as a first-year graduate student than they likely were even aware of as an undergraduate,” says **Patricia Burchat**, department chair, Physics, Stanford University. “Therefore, I think students should look for schools with a variety of programs of interest, rather than focusing on one particular research area, laboratory, or adviser,” she says. The more opportunities that are available, the better the chance will be of selecting a lab that will match your interests and for completing the venerable degree program.

Some graduate science programs offer the opportunity to perform research rotations in various laboratories and with different professors. Rotations are a way to make sure that a lab is a good match, both personally and professionally, before settling in. This is especially important since it is often difficult to switch labs later on, and doing so may add months or years to a degree program. The Ph.D. programs in physics and applied physics at Stanford give first-year graduate students the opportunity to rotate through different research groups during their first year. “A new lab rotation each quarter allows students to learn more about the research pursued by the group and gives a student the opportunity to test the ‘culture’ in the group before making a decision,” Burchat says. “The rotation system also allows the adviser to interact with the student before making the very significant commitment to mentor and support the student for her/his graduate career, and helps promote better matches between student advisees and faculty advisers and research areas,” she adds.

Financially and Geographically Speaking

Other aspects to consider include more practical issues, such as financial support, that may or may not be available to the student. One question to ask is, what is the average number of years it takes students to complete the program? since each year spent in graduate school represents tens of thousands of dollars of foregone income. In the sciences, many Ph.D. programs offer a tuition waiver and a stipend in return for committing to an intensive schedule working in a laboratory and passing up other employment. Graduate programs will typically state this information on their website. Some package deals are better than others. The cost of living of a specific area must also be considered, as should personal preferences: a student attending a college that is nestled in the countryside is likely to miss the big city after five or six years, even though it’s “just college” and they haven’t “settled down” yet.

Other questions about the design of the program include the coursework required—does it closely match a student’s interests? Does the school draw important seminar speakers within a field of research, and how often do these events take place? Does a student have the ability to participate in the academic life of the department and campus, such as by serving on faculty search committees, inviting seminar speakers, organizing student-led courses and seminars, participating in graduate student organizations? “These are all important aspects of graduate school life,” says Martin.

“One trend we have written about is that an increasing number of research universities are building large, open ‘megalabs,’ where investigators share space and supplies,” says **Jennifer Ruark**, a deputy managing editor at the Chronicle of Higher Education. “The goal is to get scientists interacting with each other and to foster interdisciplinary research—particularly in the life sciences, such as among developmental biologists, structural biologists, and chemists,” she says. “Such a learning environment may represent an attractive feature for some students.”

10 questions to ask

...a current student

1. What do you see as the strengths of the program?
2. What do you see as the weaknesses of the program?
3. How accessible are the program faculty?
4. What are the research facilities like—does there seem to be adequate funding, supplies, and equipment?
5. If you had it to do over, would you select this graduate school again? Why? Why not?
6. What are the surroundings of the school campus like? Are there leisure activities, good housing, and other amenities?
7. What is campus life like—do you have an opportunity to become involved and/or take on leadership roles?
8. Do you feel that there is an adequate level of financial and academic support to complete your studies?
9. How competitive and difficult are the academic standards here?
10. Is there anyone else I might talk to who could help provide an accurate picture of the program?

...the faculty

1. What are the major strengths of this program?
2. What are potential weaknesses of the program?
3. How would you describe the faculty?
4. Are the classes team-taught or taught by one individual?
5. How would you describe the academic environment here compared with other schools?
6. What attributes does a graduate student need to be successful at this school/in this program?
7. Do you see any common characteristics in students who have quit their doctoral degree programs here—if so, what were they?
8. What research facilities are available and how adequate is intramural and extramural funding for the labs?
9. What have recent graduates of the same program done with their degrees?
10. What unique features are offered by this school compared to other similar schools?

Strategies for Sleuthing a School

One obvious step for evaluating a potential graduate program is to visit the school. This is often part of the graduate school admissions process, during which prospective applicants have a chance to meet with students and faculty. “Increasingly, many programs recruit students to visit the school maybe after acceptance, but before the student makes a decision, trying to ensure that it is the right match,” Stewart says.

According to **Randall Hansen**, education and career coach and founder of Quintessential Careers, four steps can be taken to evaluate a graduate program. The first step is to find a list of schools that offer the degree (and specialization) sought. “There are any number of books, websites, and even some professional organizations that offer this information.” The second step is to spend time researching each graduate program, starting with each program’s website. “Review what they say about themselves, their faculty, their students, and their graduates. Look at costs, location, accreditation, culture, financial assistance, and anything else the program says about itself.” The third step is to review any rankings or outside reviews and solicit the opinions of professors regarding the programs. The fourth step is to visit the top two or three programs and talk with current students about their likes and dislikes about the program to get a sense of the university and its surroundings.

One tempting approach is to look at the online rankings and apply to the top schools in your intended area of study. Online rankings, such as those from Newsweek and U.S. News and World Report, “can be useful but not totally reliable,” Berkeley’s Martin says. “Rankings are a popular way to evaluate graduate programs,” says **Geoff Davis**, a mathematician who developed the PhDs.org Graduate School Guide, and now is a researcher with Google. “The problem with most rankings is that someone else is determining what is important,” he says. “One-size-fits-all definitely does not apply for graduate schools—there is no ‘best’ program—what’s great for one person might be terrible for another,” he says.

With so many options to choose from, making the right decision about graduate school can be bewildering. As was inscribed by the ancient Greeks at the entrance to the Temple of Apollo at Delphi, perhaps the most important piece of advice is to “know thyself.” Doing so will go a long way toward choosing the right path. Another piece of advice, perhaps not from the ancient Greeks, although you never know, is to “do your homework.” Thoroughly researching all the options is the best way to ensure selecting wisely. Finally, if all else fails, one can take solace from the fact that “nothing is irreversible,” even a decision about graduate school, although let’s hope it doesn’t come to that.

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Home Stretch to Graduation

By Elisabeth Pain—April 18, 2008

For months you’ve been focused on writing your dissertation. You’ve made scientific sense of several years of research data, pulled your results into nifty figures, and gone through several drafts of narrative. You’ve spent days checking the accuracy of the figures, the formatting of the references, and the spelling. For months, even years, your work has been driven by the anticipation of that magical moment when you realize that your dissertation is ready for submission to your examiners’ committee.

That moment, when it comes, isn’t always magical. That’s partly because it’s the start of a big transition in your scientific career, and big transitions are hard. And it’s partly due to the nature of the transition: less final triumph, more ambiguous denouement. Making it through, and, importantly, coming away with a feeling of closure, a sense of fulfillment, and some enthusiasm for the next challenge means dealing with lots of annoying distractions and carefully traversing some uneven emotional ground.

Revisions

Handing your thesis off to your examination committee can be satisfying, but it’s just one step of many before graduation. “I did not feel finished at all after submitting the thesis because I still had to do the public defense, followed by [the] editing of the final thesis for publication,” writes **Eric Seales**, now a life scientist at a biotech startup in Birmingham, Alabama, in an e-mail to *Science Careers*.

The importance of the final defense—or “viva voce examination,” as it’s called in the United Kingdom—varies across countries and institutions and with it the likelihood of unpleasant surprises on defense day. Outright failures are rare, but revisions are nearly inevitable. And that means stress.

I “was slightly worried ... that the corrections required to pass would be substantial,” **Tania Hansen**, an Australian Ph.D. now doing a postdoc in cardiovascular sciences at the University of Leicester in the United Kingdom, writes in an e-mail to *Science Careers*. Her concern “was compounded by my leaving the country, as once your examiners report comes in you only have a limited time ... to make the changes, otherwise your thesis has to be re-examined,” continues Hansen, who received a passing notification with minor revisions the day after she arrived in the United Kingdom to begin her postdoc. She had an electronic copy of her thesis, and all her raw data, packed in her luggage. “I ... got a friend in Australia to print out new copies, get them bound, and hand them in for me.”

Major revisions can be a big emotional setback because they come at a time when you feel as though you’re finished. “When there are fairly major revisions to do, that’s extremely ... difficult because you have already run the race but you have to keep running,” says **Mary McKinney**, a clinical psychologist who runs her own counseling practice for academics in Chapel Hill, North Carolina. “There is no motivation for this period because you have already passed.” This may generate some frustration and bad feelings, especially if you think your supervisor should have anticipated the revisions or don’t agree with the examiners’ verdict. “Bite your tongue, don’t say angry things,” McKinney says. “Channel that anger into your computer or your lab experiments and get it done.”

Even when revisions are minimal, they can still cause pain. “Fortunately, my committee did not require any changes,” Seales says. But the graduate school administration required formatting and grammatical corrections that took several weeks. “I can assure you that this process will be much more of a headache and take much longer than you anticipate.”

Pulled in two (or more) directions

Most Ph.D. students have a job lined up well in advance of graduation day, and moving out of the lab takes work. Many young scientists feel split between their Ph.D. obligations—making revisions, cleaning their lab space, or writing those last few papers—and their new job.

“I accepted my postdoc six months before I defended, but I didn’t start my new job until two weeks after my defense,” Rebecca wrote on the *Science Careers* forum. But she had other obligations. “The biggest professional challenge was training the postdoc who was taking over my project, categorizing my lab notebooks and freezer stocks, and cleaning out my desk, while trying to fix my thesis at the same time.”

Hansen, too, was pulled in several directions as she moved from Australia to the United Kingdom. It “was a big personal challenge. There was also a whole lot of

administration hassles with my new job before I started, which was a nightmare.” She also took a retail job after submitting her dissertation, which “focused my attention away from my thesis as I focused on getting ready to leave the country for my new job,” she says. “By the time I started my first job, I had not been in the lab for over six months ... and had to reorientate myself on how to do things ... and get used to thinking again.”

Mixed feelings

The home stretch to graduation brings a blend of emotions. “Finishing was just a relief as the whole writing process had been dragging on for ages,” Hansen says. But she also felt a little “deflated,” she adds. “No one really made a big deal about it, and that disappointed me.” A sense of anticlimax is common, McKinney says. Along with some happy feelings, “all [Ph.D. students] experience a kind of a letdown ... about that feeling of this big project not being there anymore,” she says. As Rebecca put it on the *Science Careers* forum, “I think after defending and then rushing to make the required changes to meet the graduate school’s format, I was more relieved to have it finished than anything—but I didn’t feel the rush of emotion and accomplishment that I expected.”

During this transition phase, there’s likely to be some emptiness and loneliness, too. “During that time, the only science contact I had was my fiancé, who was still doing his Ph.D. ... I felt like I had submitted and everyone had forgotten who I was,” Hansen says. Outside the lab, too, it might be necessary to work at reestablishing a social life. “When I had spare time, I initially didn’t know what to do,” Todd Graham, a Master’s graduate who is a research associate in a diagnostics start up in central New Jersey, wrote on the *Science Careers* forum.

Sometimes, unsettling psychological issues surface once the weight of the thesis lifts. “The greatest professional/personal challenge I faced during this time was purely psychological,” Seales says. He “had to deal with the letdown, the frustration and anger, of realizing that after years of hard work and sacrifice to earn my degree, that that Ph.D. didn’t qualify me in any way to go out and get a good-paying ‘real’ job,” he says. “The only way I overcame this feeling was when I left my academic postdoc less than a year into it and secured an industry job.”

Hansen’s experience was less traumatic, but some anxiety remained. “I don’t remember it as a horrific time of uncertainty. Just something that is still hanging over your head when you think about it.”

Above all, it’s an excellent time for a vacation, Rebecca wrote on the *Science Careers* forum. “Definitely take some time off between finishing and starting your next job.” But don’t head off before the i’s are dotted, the t’s are crossed, and the dissertation is off to the binders. “Finish the changes needed for your thesis ... while you are still motivated to get it done,” she continued. “Once you’re in your new job, the last thing you will want to do is look at your thesis any more!”

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Major revisions can be a big emotional setback because they come at a time when you feel as though you’re finished.





The Evolving Postdoctoral Experience

By Laura Bonetta—August 28, 2009

Science Careers conducts surveys on the postdoctoral experience every year, alternating between polling postdoc supervisors and the postdocs themselves. This year's survey, which was completed by over 700 postdoc supervisors, coincided with an economic downturn in many countries. It is perhaps not surprising that, when asked about what career trends they were noticing, many supervisors expressed concern about the job market.

“When I was doing a postdoc, I don't remember anyone ever being out of work or not being able to find a position. Whereas now I do hear about postdocs who are looking for work,” says **Yvonne Paterson**, dean for postdoctoral research training and director of the biomedical postdoctoral program at the University of Pennsylvania in Philadelphia. Paterson, who completed a three-year postdoc before joining the faculty at Penn in 1982, says she has noticed an increase in the age of first faculty appointments and promotions. “Most faculty we hire have done more than one postdoc,” she says.

The data support Paterson's observations. According to the National Research Council's report “Bridges to Independence,” the age of first independent faculty appointments for Ph.D.s has been rising steadily from 34 in 1979 to 38 in 2003. (<http://bit.ly/eYIVO>)

In addition, the share of recent science and engineering Doctorate holders hired into full time faculty positions fell from 74 percent to 44 percent from 1972 to 2003, whereas the share of those reporting to be in a postdoc position rose from 13 to 34 percent. (National Science Board, 2006, *Science and Engineering Indicators 2006*, www.nsf.gov/statistics/seind06/)

And the phenomenon does not seem to be U.S.-specific. “Some people have been postdocs for a very long time, especially if they are in a lab that is well funded,” says **Edith Sim**, director of graduate and research staff training for the division of medical sciences at the University of Oxford, United Kingdom. “Many postdocs get a faculty position after only one postdoc, but I know many others who have done several postdocs. Some of them have been postdocs for as long as 11 years.”

Are Postdocs Getting Longer?

Although it may be a longer haul to an academic position, the length of individual postdoc appointments has actually gotten shorter. When *Science Careers* survey participants were asked the average length of the postdoc experience in their own labs, 67 percent of those polled in 2005 said one to three years and 29 percent said four plus years. In 2007, however, 79 percent said the average postdoc appointment was one to three years and 16 percent four plus years; in 2009, 76 percent said one to three years and 19 percent four plus years. Thus, it seems that the average length of a postdoc stint decreased sharply from 2005 to 2007 and has been fairly constant since then.

One of the factors that may account for shorter postdoc appointments is that many universities and funding bodies in the United States and Europe have put in place limits on the length of time a postdoc appointment can last. These limits typically range between three and seven years, sometimes including previous postdoc experiences within that time frame.

Ola Hermanson at the Karolinska Institute in Sweden supports limits on postdoc appointments, but points out that in some cases they can be too restrictive. In Sweden, researchers are normally eligible for assistant professor positions only within five years of obtaining a Ph.D. “Nowadays it takes longer to publish in a good journal. Five years is really not enough time to establish yourself,” he says. “Especially because after graduate school you usually take some time before starting a postdoc. So by the time you start, the time you have left to do your research could actually be only three years.”

Another potential disadvantage to short postdocs is that researchers become more focused on getting results fast. “Young scientists need to see the bigger picture,” says **Nick Birch**, an entomologist at the Scottish Crop Research Institute in Dundee. “Some research topics may not be in vogue now but will be in 10 years.” But, Birch points out, it may be difficult to see a big picture when postdocs are so short. At his own government research institution, postdocs are typically funded for only one to three years, although appointments can be renewed if additional funding is available.

'Alternative' Careers

Another trend that some 2009 survey participants identified is that there are more opportunities for postdocs to pursue outside of academia. "I did my postdoc in the early '90s at the National Institutes of Health. At that time the only jobs were academia or drug companies," says **Jonathan Dinman** at the University of Maryland, College Park.

Postdocs today are able to pursue careers in the biotech industry, government, research advocacy, science writing, intellectual property, and so on. Regardless of the career choice, Dinman points out that it is part of the supervisor's responsibility to offer to support. "I don't have to clone myself," he says. "My job as a mentor is to recognize the strength of each person in my lab and guide them toward their strength."

Although most postdocs begin their training aiming for an academic career, according to informal surveys by the U.S. National Postdoctoral Association (NPA), many end up choosing other options. "Postdocs should consider all career options," says **Cathee Johnson Phillips**, NPA's executive director, adding that NPA is no longer referring to careers outside of academic research as 'alternative' careers. "If the data we have give us an accurate picture, an academic career may actually be the alternative career," says Phillips.

In some countries, though, opportunities for postdocs in academic research might be on the rise. "The intensity of funding is increasing annually and can be available from many sources—the National Foundation, the local government, and local institutions," says **Jia Wei Zheng** at Shanghai Jiao Tong University in China. "Many Chinese postdocs still go abroad to do research, but nowadays more and more of them come back to China to continue their career."

More Recognition for Postdocs

Another positive trend that 2009 survey participants identified is that postdocs today are more likely to have higher salaries than 10 years ago and to

have benefits. According to data from the US National Science Foundation, of the postdocs who received their Ph.D.s between 2001 and 2006, 91 percent received health benefits and 50 percent received retirement benefits from their current or most recent postdoc employer. (National Science Foundation, division of science resources statistics, Postdocs Participation in Science Engineering and Health Doctorate Recipients, 2008, www.nsf.gov/statistics/infbrief/nsfo8307)

"I think there is an increased awareness of the contributions postdocs make. And people are more aware of the need to provide benefits. In general, the postdoc community is more in the forefront," says Phillips. "But that does not mean that we don't still have a long way to go."

One of the main factors that has served to increase such awareness is the establishment of postdoc offices and associations at many universities. At the University of Alberta in Edmonton, Canada, the postdoc office has made "the situation between postdoc and supervisor really clear," says biochemistry professor **Joel Weiner**. "Expectations used to be loosely defined. Now we have a formal letter that lays out the project the postdoc will work on, the rules about the maximum length of the appointment, and enforced salary levels."

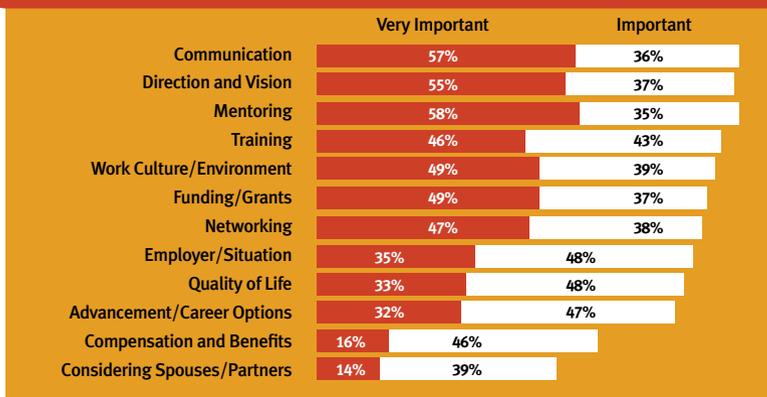
Under new regulations, postdoc positions at the University of Alberta cannot last longer than five years. "I think it has been a really good change," says Weiner. "But some people don't like it. You can no longer have a postdoc in your lab for six or seven years at \$20,000 a year."

Lawrence Livermore National Laboratory in California, a government laboratory funded primarily by the U.S. Department of Energy, hires about 50 percent of its postdocs as permanent staff members. **Ian D. Hutcheon**, deputy director of the Glenn T. Seaborg Institute at Lawrence Livermore, has noticed that in recent years there are more opportunities for women to be postdocs and then move on to obtain permanent positions. "We have a pretty generous maternity leave policy; there is much greater awareness of the needs for all postdocs to spend time with their families," says Hutcheon.

This awareness was lacking when **Lynn Zechiedrich** did her postdoc at the University of California, Berkeley in the early 1990s. "I did not know whether I even had any benefits until I became pregnant," she says. "I just did not think about it. I was focused on my work." When her son was just seven weeks old Zechiedrich was asked to return to work. "It never occurred to me I could ask for more time," she says. "Today postdocs are not so clueless. They will speak out."

The change, Zechiedrich and others believe, has to do with postdocs being savvier and more aware, as well as a general change in culture. "There are more women in science, more families, and more acceptance of family," says Zechiedrich, who is at the Baylor College of Medicine in Houston, Texas. "There is also more appreciation of the work being done by trainees and willingness to treat them well."

Importance of attribute groups in contributing to a successful postdoc experience



Where Have the Outstanding Postdocs Gone?

One change from this year's survey compared to the one conducted in 2007 is that only 39 percent of supervisors said they are currently supervising a postdoc that they consider to be outstanding—down from 45 percent in 2007.

In some of the “newer” research fields, outstanding postdocs are still hard to come by. “In our particular field, bioinformatics, it is rare to find postdocs with really strong skills both in the life sciences and in a technical area. For example, a mathematician who is able to formulate and pursue a biologically relevant research question or someone with lab experience who is able to develop new models or algorithms,” says David Kreil of Boku University in Vienna. He points out that most current Ph.D. programs do not provide this kind of “dual-training.”

Most postdoc supervisors who were interviewed for this article, however, did not think that the quality of postdocs had changed. “I have not seen a decrease in the availability of qualified people but we all like to hire the best and the brightest. It's a very competitive market. We all try to hire people who are really good but there are only so many of them,” says Hutcheon.

So what should a supervisor look for? The most common attribute 2009 survey participants looked for when recruiting a new postdoc was a strong research experience; it was cited by 82 percent of those polled. Other common factors

Comparison of attribute rankings from principal investigators (PIs)

PI Rankings 2009	Postdoc Rankings 2008	Attribute
1	7	Communication
2	1	Direction and Vision
3	4	Mentoring
4	9	Training
5	N/A	Work Culture/Environment
6	2	Networking
7	5	Employer/Situation
8	N/A	Quality of Life
9	6	Advancement/Career Options
10	8	Compensation and Benefits
11	10	Considering Spouses/Partners

The table compares certain attributes of a successful postdoc, as rated by PIs in the 2009 survey, and postdocs in the 2008 survey. Of note are the clearly divergent views on Communication, Networking, and Training.

included interest in working in new fields (53 percent), having a graduate adviser with a good reputation (48 percent), and coming from a good research institution (34 percent).

One thing that has not changed in this year's survey compared to the 2007 one is what supervisors believe makes a successful postdoc experience. When survey participants were asked to rank the importance of several factors, the majority agreed that conducting high quality research (79 percent), learning to work independently (66 percent), and publishing work (65 percent) were most important to a successful postdoc experience. These responses were virtually unchanged from two years prior.

Similarly when participants were asked to rate the importance of 12 groups of attributes in contributing to a successful postdoc experience, the three that came up on top—communication (91 percent), direction and vision (92 percent), and mentoring (91 percent)—were also the same as those ranked highest in 2007 but differed in certain aspects from 2008 postdoc rankings (see table, opposite).

Scientific careers have undergone many changes in recent years. Some changes have to do with the funding situation, others with the type of research that is being conducted, others yet, with the rules and regulations put in place at institutions. But one thing that will probably never change is why people do science. “If you don't love doing science, you should never pick this career,” says Hermanson. “We live for the moment of discovery. Three hundred sixty days could be pretty boring. But it's definitely worth it for those five days of excitement.”

Survey Methodology

This year's survey aimed to determine what factors contribute to a successful postdoctoral experience from the supervisors' point of view. Starting February 3, 2009, 717 postdoc supervisors in North America, Europe, and Asia/Pacific Rim responded to an online survey. In addition to being asked to rate the importance of various attributes to the postdoc experience, supervisors were asked to identify their best postdoctoral fellows and note their strengths. They were also asked to comment about the ways in which the postdoctoral experience had changed in recent years in both positive and negative ways. The majority (87 percent) of survey participants were located in North America (59 percent) and Europe (28 percent). The remainder were located in Asia/Pacific Rim (10 percent) or other areas of the world (3 percent). Most (67 percent) worked in academic institutions, followed by government organizations (9 percent), nonprofit research organizations (7 percent), and hospitals (6 percent).

● This article originally published as a *Science*/AAAS Business Office feature Available online at: bit.ly/cFokJG



Faced with a shaky economy and an increasingly competitive job market, postdocs are being forced to take a long-term view of their positions. That means ensuring that it provides not only additional research training and publications, but also the necessary connections and experience that will be needed for a future career. It also means staying flexible and frequently reevaluating career plans.

The Postdoc Experience: Taking A Long Term View

By Laura Bonetta—August 27, 2010

Postdoc supervisors and their postdocs don't always see eye to eye when it comes to the factors that contribute to a successful postdoc experience, according to the annual surveys conducted by *Science Careers*, which alternate each year between asking the opinions of postdoc supervisors and the postdocs themselves.

The 3,500 or so current and former postdocs who responded to this year's survey put having a supervisor with adequate funding and opportunities for networking at the top of their list. On the other hand, the postdoc supervisors who responded to last year's survey ranked these factors as 6th and 7th most important, respectively. Supervisors put mentoring, direction and vision, and communication at the top of their list.

"I believe these differences are in large part due to different perspectives," says **Cathee Johnson Phillips**, executive director of the National Postdoctoral Association (NPA). Whereas postdoc supervisors may view the postdoc years mainly as an opportunity to obtain further training and improve research skills, "more and more postdocs are thinking long-term in regard to their career positions," says Phillips.

What does this mean? "You have to be proactive and get the experience you will need for your future career," says **Sarah Gaffen**, associate professor at the University of Pittsburgh. "If you want to be an academic PI, talk to people who are in search committees who can tell you how you are doing."

Networking Is Key...

Establishing a network of colleagues who can provide guidance and support and help open doors is key to a successful postdoc experience, according to 92 percent of this year's survey respondents.

Former postdoc **Jamie DeWitt** says her postdoc adviser at the U.S. Environmental Protection Agency (EPA) made sure she met his network of colleagues at scientific meetings and asked her to co-author review papers and book chapters with him. "All these things helped to introduce me to the broader scientific community," says DeWitt.

But she also took some initiative networking on her own. "I was involved in the postdoc association at EPA and was a postdoc representative for the Society of Toxicology, so I met a lot of people that way," she says. "I always tell postdocs not to be afraid to walk up to scientists at conferences and say 'I read your paper and wanted to meet you.'"

Being known among her colleagues helped DeWitt obtain her current faculty position at East Carolina University. "I would say that both having published several papers and networking were very important," she says. "The publications helped support what my colleagues were saying about me."

Networking was critical for **Eleni Tzavara** to obtain her current position at the National Institute for Health and Medical Research (INSERM) in Créteil, France. While she was a postdoc at Eli Lilly and Company in Indianapolis, Indiana, Tzavara attended a scientific conference. There, she met a neuroscience department director from INSERM who encouraged her to apply for a faculty position at INSERM. "I still

Postdocs rate factors that contribute to a successful postdoc experience, plus rankings compared to 2009 PI Survey

Attribute	Very Important	Important	Postdoc Rankings 2010	PI Rankings 2009
Funding/Grants	57%	36%	1 (tie)	6
Networking	55%	37%	1 (tie)	7
Advancement/Career Options	58%	35%	3 (tie)	10
Direction and Vision	46%	43%	3 (tie)	2
Mentoring	49%	39%	3 (tie)	3
Employer/Situation	49%	37%	6 (tie)	8
Communication	47%	38%	6 (tie)	1
Spouses, Partners, Family	35%	48%	8	12
Training	33%	48%	9	4
Compensation and Benefits	32%	47%	10	11

had some time left in my postdoc so I was not looking for a position at that time,” recalls Tzavara. “But I decided to apply and had to go through a really tough evaluation process. Once I had an offer it was hard to say no.”

...And So Is Funding

Both DeWitt and Tzavara had productive postdocs in part because the resources were in place at their postdoc labs to hit the ground running. “A postdoc at EPA is very project oriented,” she says. “The support system was in place for me to do research in a timely manner so I was able to get papers out quickly.” Ninety-two percent of postdocs polled in this year’s survey ranked having a supervisor with funding or grants at or near the top of their list for a successful postdoc experience. Tzavara had a similar experience. “The resources in industry are very good and the scientific environment challenging, so I was able to be very productive,” she says.

The importance of funding hit home for **Virna Dapic** when she was doing a postdoc at the Moffitt Cancer Center in Tampa, Florida. She saw the impact her PI’s struggle to obtain funding had on postdoctoral fellows and graduate students. As a result, she decided that “academic research was not meant for me,” she says. “I didn’t want to constantly worry about the money and the ability to maintain a research lab.”

Planning For Your Career

An increased awareness of the need for long-term planning may explain why having “advancement opportunities and career options” jumped from 6th to 3rd place in the list of factors contributing to a successful postdoc experience in this year’s survey compared to the one conducted two years ago, which also polled postdocs.

“My advice to postdocs is to use the position to train yourself for the job you want to do and also find out if it is the right job for you,” says Gaffen. “But also be realistic.”

At the start of her postdoc Gaffen was unsure an academic PI position would be right for her. But after publishing several papers and gaining recognition from her

colleagues, she started to think a faculty position might be within her reach. “But I also realized that if I was going to do that job I would have to get the skills I needed for it,” says Gaffen.

One thing Gaffen did was take courses in writing papers and grants. Her postdoc adviser also presented her with networking and grant writing opportunities to help her gain the necessary skills. “Success in obtaining a grant, particularly one that you can take with you to a faculty position, is worth a top journal paper to a search committee,” says Gaffen.

Planning For Two

Postdocs today are not only putting more emphasis on planning their own careers but also taking into account those of their partners. Over half (56 percent) of the survey group indicated that their career choice was limited by their spouse’s or partner’s career. Furthermore, accommodations made for spouses, partners, and family jumped from 10th to 8th place in the list of factors that postdocs view as contributing to a successful experience in the 2008 and 2010 surveys, respectively.

“We decided we would stay together and always look for positions in the same geographical areas,” says **Maribel Vazquez**, an assistant professor in mathematics at San Francisco State University, where her husband, **Javier Arsuaga**, also holds a faculty position. “This was just a personal decision. It is challenging, but it has always worked out for us.” The key, says Arsuaga, “is to both be highly competitive. Then, if an institution really wants one of the two, the chances are higher that they will consider interviewing the other one.”

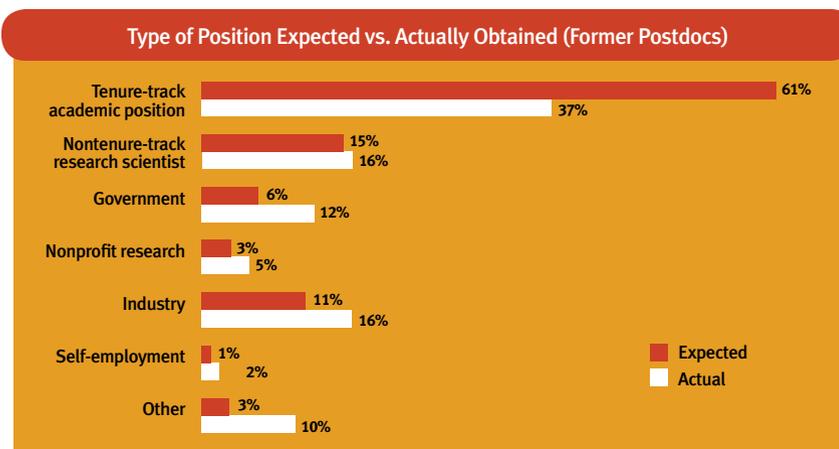
Calling All Mentors

To plan their careers many postdocs rely on advice from one or several more experienced scientists who are their mentors. More than half (61 percent) of the survey group knew someone they would describe as a mentor.

In most cases (75 percent) the mentor was either the individual’s supervisor (52 percent) or Ph.D. (23 percent) adviser. But sometimes the relationship with the supervisor is strained, as it happened to be for **John Antonakis**, currently a professor of organizational behavior at the University of Lausanne in Switzerland.

Having obtained a Ph.D. in leadership management at Walden University in Minnesota, Antonakis did a postdoc at Yale University in Connecticut. “I wanted to supplement my doctoral training,” says Antonakis. “The Yale name opens doors.” He says he greatly benefited from the environment at Yale and the reputation of the university, but his adviser “did not provide the support and training I needed as a postdoc.”

As a result Antonakis collaborated with mentors at other institutions. “They worked with me on publications and helped me get my first faculty position,” says Antonakis.





“...be realistic about your situation and be ready to revise your end-goal if you need to.”

When Things Don't Go As Initially Planned

Even with the best planning, the unpredictability of scientific research and the job market makes it difficult to ensure success. When a postdoc appointment does not lead to an academic position, many people choose to seek additional postdoc positions—a practice that is becoming increasingly common.

Three-fifths (60 percent) of the former postdocs polled in this year's survey held only a single postdoc position, while 29 percent held two such positions. Relatively few (11 percent) former postdocs held three or more positions. Forty percent of the survey respondents who held multiple postdocs said they did so due to poor job prospects; this percentage is similar to those reported in postdoc surveys conducted in 2006 and 2008, but 13 percent higher than that in the 2004 study.

Christian Beaulé's initial goal, when he started his postdoc in 2003 at the University of Illinois at Urbana-Champaign, was to stay for a few years and then return to his native country of Canada to a faculty position. But after a second postdoc at Washington University in Saint Louis, Missouri and fewer publications than he had hoped, Beaulé will be returning to Canada for another postdoc. “I will start a third postdoc to get more publications, but also for family and immigration reasons,” he says.

And while he continues to seek academic positions, he will be keeping all his options open. “I am looking for academic positions in research but I am also looking at teaching, government, and industry positions,” he says.

Although Beaulé had to adjust his expectations, he says, in retrospect, he would not do things differently. “In terms of papers I was not as productive as I had hoped but I am happy with what I did. In terms of science, learning, and professional development, this was a very productive postdoc experience,” he says. “My advice to postdocs is to try to have fun but also have an end-goal in mind and try to make sure that the postdoc experience helps you reach that goal. Also, be realistic about your situation and be ready to revise your end-goal if you need to.”

Having a Plan B

Beaulé's situation is not unusual. Today more than ever postdocs are seeking career opportunities outside of bench research (“The evolving postdoctoral experience,” *Science*, 2009, doi:10.1126/science.opms.r0900076). Sixty-one percent of former postdocs and 57 percent of current ones hoped to get tenure-track academic positions after completing their postdoctoral studies, but only 37 percent of the former postdocs who wanted to work in a tenure-track academic position ended up doing so. (see graph, p.28)

Julie Belanger switched research areas when she began her postdoc at the National Cancer Institute at Frederick, Maryland, from polymer chemistry to chemical biology. “In this job market I am not sure I would advise postdocs to drastically change research topics,” she says. “I am very diverse and learned a lot about many aspects of chemistry, from nanomaterials to virology, but I feel I am a harder sell. My passion for an academic career comes across in person, but getting an interview has not been easy.” On the flip-side, Belanger's diverse skill set and broader experience could serve her well now that she is also looking for government positions at the Food and Drug Administration and Centers for Disease Control and Prevention that are not research related.

Postdoc **David Proctor** has instead turned his sights to a career in science policy. “When I realized that my postdoc research wasn't turning out as I had hoped, I began to get more involved in my local postdoc association,” recalls Proctor, who is from the United States, but is doing his postdoc at the University of Dundee, Scotland. “This later led to my involvement in the creation of the U.K. Research Staff Association, the British counterpart of the NPA. Overall this has reinforced my interest in science policy.”

There are many considerations that go into choosing a postdoc position, which often need to be weighed against one another. Most postdocs' advice is to visit the prospective lab and spend time speaking with the head of the lab and its members to see if it will be a good fit.

In the end, whether a postdoc is successful depends on someone's interests, needs, and aspirations. The key is to make sure that the experience provides the necessary skills, connections, and training for moving on to the next position—whatever that might be.

Survey Methodology

This year's survey was launched on March 16, 2010, with an e-mail invitation to about 60,000 current and former postdocs worldwide. Of the 3,475 qualified surveys that were collected 49 percent came from individuals in North America, 29 percent from individuals in Europe, and 22 percent from individuals in Asia Pacific or the rest of the world. Most (79 percent) postdoc positions were held in academic institutions. Life and medical sciences were the most common disciplines, being cited by 62 percent of respondents. A much smaller group of individuals (10 percent) worked in chemistry, while the remaining 28 percent worked in other non-life science disciplines. Most current postdocs (62 percent) were between 31 and 40 years of age. A smaller group (30 percent) was 30 years old or younger, while fewer still (8 percent) were 41 or older.

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Additional Resources

Career-Related Resources from Science and AAAS

- Science Careers Job Board sciencecareers.org
- Science Careers Forum sforum.aaas.org
- Other Career-Related Booklets sciencecareers.org/booklets
- Career-Related Webinars sciencecareers.org/webinars
- GrantsNet sciencecareers.org/funding
- Communicating Science communicatingscience.aaas.org
- Science & Technology Policy Fellowships fellowships.aaas.org
- Science News Writing Internship aaas.org/careercenter/internships/science.shtml
- AAAS Mass Media Science & Engineering Fellows Program aaas.org/programs/education/MassMedia
- ENTRY POINT! Internships for Students with Disabilities ehrweb.aaas.org/entrypoint
- CTSiNet and MySciNet Social Networking Communities community.sciencecareers.org

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- Getting Yourself Mentored bit.ly/di10Lo
- The World Is Your Lab on a Postdoc or Sabbatical Abroad bit.ly/conxcl
- Making the Most of Your Contacts bit.ly/cdXhUO
- Preparing for Your Post-Ph.D. Career bit.ly/1zrwdW
- Making the Leap to Independence bit.ly/a5Co3J

Books

- *The Chicago Guide to Your Career in Science: A Toolkit for Students and Postdocs*
Victor A. Bloomfield and Esam E. El-Fakahany
- *Put Your Science to Work: The Take-Charge Career Guide for Scientists*
Peter Fiske
- *Getting What You Came For: The Smart Student's Guide to Earning a Master's or a Ph.D.*
Robert L. Peters
- *What Color is Your Parachute? A Practical Manual for Job-Hunters and Career Changers*,
Richard Nelson Bolles
- *Making the Right Moves: A Practical Guide to Scientific Management for Postdocs and New Faculty*
BWF & HHMI hhmi.org/labmanagement

Information from Other Organizations

- American Chemical Society www.acs.org/careers
- American Physiological Society the-aps.org/careers
- American Society for Cell Biology bit.ly/14sAgg
- American Society for Microbiology www.microbiologycareers.org
- National Postdoctoral Association nationalpostdoc.org/careers
- National Institutes of Health training.nih.gov

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