The UK Academic System: hierarchy, students, grants, fellowships and all that

Geoffrey J. Barton
School of Life Sciences
University of Dundee
Dundee,
Scotland, UK.

g.j.barton@dundee.ac.uk

Version 1.0
Copyright © G. J. Barton, 2008.

Introduction

In this article, I give an overview of the career path for a scientist in UK academia, from school at 18 years old, to a senior academic research appointment. The article is aimed at those unfamiliar with the education system in the UK and with the meaning and distinction between the words “undergraduate” and “postgraduate” and job titles “Reader”, “Fellow”, “Lecturer” and “Professor”. It is intended as a guide for those who are thinking of a career in UK academic science, or have already embarked on one, so there are also quite a lot of suggestions and bits of advice for what you might think about at each stage. If you find anything here helpful, do let me know. Likewise, if you see clear errors or omissions let me know and I will try to incorporate your suggestions in later versions.

The Excitement of a Scientific Career

All children constantly ask the question “why?” or “how does that work?” However, this questioning often stops once you have grasped the essentials of your surroundings and have settled into a routine job. The great thing about being a scientist, particularly in academia is that you never stop asking why? Your whole daytime job is about trying to work out new things about the world around you. In “blue skies research” you are not thinking about applications of what you are doing, just being driven by the childish curiosity. It is very satisfying just to know the answer, even if it is hard to explain to a non-specialist. However, your apparently obscure original discovery might in the future lead to better health or prosperity for millions. In contrast, applied scientific research focuses on problems that can have a direct health or economic benefit for millions of people, but even with applied science, the core research is curiosity driven. Scientific discoveries and the technology that arises from scientific knowledge drive the world; so being a part of the discovery process is particularly satisfying.

While there are difficulties and uncertainties in any career, academic research offers a lot of freedoms that are not present in many jobs. Perhaps the biggest appeal beyond the ability to remain a curious child all your working life is the fact that once you are an "independent" researcher, you do not really have a boss in the traditional sense. You set the direction of your work. You are responsible for raising the funds to do the work. You get the credit for what you have achieved, and can bask in the glory, fame, and sometimes fortune that results.

Getting to University

This document is not about how to get into a UK university, as an undergraduate (see below). However, for the sake of completeness I've written the following few lines. For full details look elsewhere...The UK is made up of England, Wales, Scotland and Northern Ireland. Scotland has a different education system to England and Wales (I don't know about Northern Ireland). In England and Wales, most students study 3 or 4 "A-Levels" between the ages of 16 and 18. "A" stands for "Advanced" and since you only study three subjects; A-level courses tend to cover scientific subjects in much more depth than in countries where more subjects are studied before university. In Scotland, the system is different, with more subjects studied to 17, and then the option of doing "Advanced Highers" for a year. As a consequence, students who have studied A-levels or "Advanced Highers" can normally enter Scottish Universities in Year 2 rather than Year 1.

Academic Career in Summary

The UK academic system has an old and established hierarchy of appointments, but these are different to those in many other countries such as the USA and the rest of Europe. What I describe below is a general overview based on my own experience and that should apply to most UK institutions. However, some institutions will doubtless have their own peculiarities of which I am unaware. If you feel strongly about something I have got wrong, then let me know and I will add more explanation.

Research active scientists will normally have a "laboratory" or "lab" in which their research work is carried out. "Laboratory" may conjure up thoughts of a room filled with test tubes, bubbling liquids and complex equipment. Many labs do look like this, but a "lab" might just be a bunch of desks and computer workstations. Scientists do research in their lab, normally with a team of people and then "write it up" for publication in a journal (more about that later) so that other scientists can read about their work and build on it, or test it themselves. Scientists are judged largely by their publications, so a goal of all scientists is to publish good work frequently in good journals.

I'll talk first about traditional university appointments, then about the world of Ph.D. student, post-doc research assistant (abbreviated to PDRA, or just RA) and fellowships that lead up to these appointments.

The basic hierarchy after you have a Ph.D. (explained below) goes: post-doc, lecturer, (senior lecturer)/reader, professor.

Copyright © G. J. Barton, 2008

Traditionally, university staff have three jobs: They do original research, they teach and they perform administration. Increasingly, in the more successful research-active departments, these activities are more separated, with staff having a stronger teaching or research commitment, rather than having to devote a lot of time to both.

A *lecturer* is the most junior traditional "independent" position. Lecturers will normally have a Ph.D., but this is not true of all subject areas. They will carry out original research and teach undergraduate students. Lecturers in science will normally have completed several years as a post-doc before taking up the lectureship.

A *senior lecturer* position is a career advancement for a lecturer. Senior lectureships are usually awarded based on excellence in teaching/administration rather than research.

A *reader* is on a similar level to a senior lecturer, but is usually awarded the title for their research success.

All positions from RA up to Reader/Senior Lecturer are paid on a UK nationally agreed pay spine.

The most senior academic job title is *professor*. Professors are said to hold a *chair* in a subject or subject area, so are often referred to as "The Chair in/of X" where X is their subject. Chairs may be *established* or *personal*. An established chair is one that is not tied to the individual who currently holds it. In other words, if the established chair in molecular biology at a university leaves, then the chair still exists and can be filled by someone else. A personal chair on the other hand, is tied to the individual who has it. If they leave or retire, the chair (their job) is not guaranteed to be available for another person to take up. The University may decide to spend the money on something else! Personal chairs are often used to promote academics who have reached a high standard in teaching and/or research and have also reached the top of the national pay spine for readers/senior lecturers. This is because it is nationally agreed that there is a professorial minimum salary, but no maximum. All professorial salaries are negotiated, but professors receive any annual cost-of-living increases that are nationally agreed. Personal chairs are also often used when appointing star researchers to a university, since they allow flexibility in salary negotiation.

Clearly, not all professors are equal. The salary a professor commands will depend on many factors, not least their international standing in their research field and the scarcity of people with their unique skills. Professors are normally the people who hold the most senior positions within departments and set the steer for a department's direction.

Scientists rarely want to stop doing what they do when the reach the age of 65 (or 67 in some institutions), so an *emeritus professor* is a professor who is officially retired, but still active in their university.

Copyright © G. J. Barton, 2008

Getting there...

Undergraduate

An undergraduate student is a student who has yet to obtain their *first degree*. In the UK a first degree is normally a *Bachelor's* degree. For example: Bachelor of Science (BSc), Bachelor of Arts (BA), etc. Bachelor's degrees take either 3 or 4 years to complete. In some institutions, there is a distinction between an *ordinary* degree and a degree with *honours*. The ordinary degree might be awarded if the candidate does not complete the full honours course, but the precise regulations vary from institute to institute. Some institutes will only offer degrees that are "ordinary", but normally when starting a degree one is aiming to complete it with honours and obtain a high classification. Bachelor's degrees with honours are graded: *1st Class*, *2nd Class* and *Third Class*. The Second class is further divided into *upper* and *lower* divisions. The process of awarding the first degree is called *graduation* and so once the degree is awarded, the student is referred to as a *postgraduate*. As a consequence, a student who is studying beyond their bachelor's degree is called a *postgraduate student*. This is sometimes shortened to *graduate student,* though this is an import from the USA where that is the normal term. Funding to complete a bachelor's degree comes from a mixture of sources. Some funds go to the university directly from central government, but increasing proportions of funding are from the student themselves in the form of parental aid, and/or government student-loans. Your chances of being accepted for a higher degree and getting a grant to pay for your tuition and living expenses are much better if you have a 1st class or upper 2nd class honours degree. Indeed, you will not normally get a research council grant for a Ph.D. unless you have a 1st or upper second class degree.

Postgraduate

A postgraduate student will be studying for a *higher* degree. Higher degrees may be *masters* or *Ph.D.* A *master of science* (M.Sc.) degree is normally a 1-year taught course with lectures, but with a significant research project as well. Masters courses usually aim to take graduates and educate them in a specialised area that would not normally be covered in an undergraduate degree. Alternatively, the masters course, may allow graduates of one discipline to gain a good understanding of a different discipline.

The M.Sc. and M.Res.

A *master of research* (M.Res.) degree is also open to graduates and lasts 1-year, but typically has a much smaller taught component than an M.Sc. The M.Res is dominated by a research project and assessed primarily by the quality of a written thesis. Having said all this, some institutions have M.Res courses that look a lot like M.Sc courses and vice-versa. Some institutions call their M.Res an M.Phil., but they amount to the same thing. When considering any masters course, you should look

Copyright © G. J. Barton, 2008

carefully at what it offers in terms of taught material versus research experience and choose a course that suits what you want to do. It is also essential to look carefully at the institution and its research record and in particular the research record of the staff that will teach you or supervise your project. Ideally you want to be taught by people who are clearly research active in the field of the masters course, not those who have success in a different subject, and have just read a text book or two in the subject you are applying for. Be aware though that competition for M.Sc places at the top research institutions will be higher than at institutions with a poorer research record.

The Ph.D.

The Ph.D. is open to graduates with a UK bachelor's degree or equivalent qualification from outside the UK, there is no need to do a UK master's degree first. The traditional UK Ph.D. (Doctor of Philosophy. In Oxford, these are called D.Phil., but are the same thing) lasts for 3-years. The postgraduate student works full-time with a research supervisor on a project the supervisor has suggested. The student will learn the research techniques prevalent in the supervisor's laboratory, should also learn to write scientific papers for publication and gain experience of presenting their results orally with appropriate visual aides and through other media (e.g. poster presentations). The student has to write-up their work in a *thesis* that must be a reasonably self-contained work on the subject. The rules on what constitutes a thesis vary a bit from institute to institute, but the first chapter of a thesis is a review of the work done in the field prior to the Ph.D. work, followed by several chapters describing the original research done by the student. Unlike in many other countries, a thesis does not have to contain work that has been published in the scientific literature, but it helps a lot if it does. UK Ph.D. theses are typically 200-300 double-spaced pages long including figures and tables and, assuming the student has plenty of results, take 3-4 months of full-time work to write.

Ph.D. theses are examined by two examiners: The *external examiner* will be an expert in the field, but must be from a different institution to the student/supervisor and not have worked with them on any of the research described in the thesis. The second examiner, the *internal examiner* is usually from the same department as the student/supervisor and again, should not have worked directly with them. Both examiners read the thesis, usually write independent reports, and then together carry out a *viva* of the student. The viva is an oral defence of the thesis by the student. Normally, the only people present in the viva are the two examiners and the student. Some institutions allow for others to sit in on a viva, but this is rarely done. The job of the external examiner is to assess the scientific merit of the thesis in the light of their knowledge as an independent expert in the field. The internal examiner will often not be expert in the particulars of the work done by the student, but will be familiar with theses and the subject in general and so can help in the assessment. The internal examiner can act to moderate excessive demands of an external examiner, explain any extenuating circumstances of the student and their supervisor etc. The outcome of the viva is a recommendation by the examiners about the award of the Ph.D. degree as set out in a report that they write jointly. The exact types of recommendation vary from institute to institute, but are broadly: Accept the thesis as is; Accept with minor corrections; accept after major corrections and a second viva; award an MRes; Fail. It is normally the internal examiner's job to make sure the student has done the corrections. Major corrections may require additional research work to be carried out. The time allowed for corrections varies from institute to institute, but often a month or two is allowed for minor corrections. However, it is always best to do them as quickly as possible.

Increasingly in the UK, Ph.D. courses are being offered that last 4-years rather than 3. Often the first year allows the student to do a rotation between different laboratories in an institute and so gain experience of different research techniques and environments, before they settle on a project with a supervisor. In some 4-year programmes the student spends the first year doing a full M.Sc course as a prelude to the Ph.D. This is an evolving area.

Ph.D. Funding

Funding for Ph.D. positions in the UK is almost always by a *grant* from some funding body such as the MRC, BBSRC, Wellcome Trust, CRUK etc. Grants fund the Ph.D. student's living expenses and whatever fees the university demands. Some grants are more generous than others regarding expenses for experimental work and the stipend paid to the student. Each funding body has its own restrictions on who is eligible to receive funding, and funds are limited, so Ph.D. positions are competitive in each institution. Funding for Ph.D. students is nearly always awarded to the department or the research supervisor, *not* the student. In other words, as a potential Ph.D. student you cannot apply to BBSRC for a grant directly, but must win one of the grants that your potential supervisor has available to them. Unfortunately, most funding is specific to UK-citizens living in the UK. The UK research councils will also fund students from EU countries, but then they will only fund the university fees and not living expenses. This means that funding for living (typically £12-15K per year) must come from somewhere else. Funding for non-EU citizens is scarce, but does exist. For example, the Wellcome Trust studentship schemes allow for non-UK students, but these are very competitive.

How to choose a Ph.D. supervisor

Although most undergraduate science degrees give you a taste of what research is like, it is only when you start to carry out work towards a Ph.D. that you really understand what is involved. A Ph.D. is a training exercise in research methods and communication, so you should aim to do your Ph.D. in a laboratory that is very research active. However, it can be difficult when you are just finishing an undergraduate course to know where the best places are. It is equally difficult for most people to decide what research area they would like to work in! Your undergraduate course will have given you a broad introduction to your subject, and your undergraduate project supervisor should be able to advise you on good laboratories across the UK where you should apply. Of course, you can also work this out for yourself by reading recent research papers in the area that interests you and identifying scientists in the UK that are publishing in this area and who are doing work you find exciting.

Do not assume that getting a Ph.D. place with the biggest name in the field is always best, though it usually is a good idea. Big names typically are not in the lab much, or

Copyright © G. J. Barton, 2008

indeed in the country. They may have a large group with many post-docs who will end up supervising your Ph.D. This might work very well, but it can also be a disaster if your project has not been clearly delineated from that of others in the group. The plus point of being in a big lab is that you will be exposed to a lot of expertise and help. If the lab has a good culture of communication and mutual assistance, then this can be a fantastic environment to work in. The downside is that your Ph.D. research might be highly collaborative and so harder for you to show what your personal contribution is to any research outputs (publications). Working with a supervisor who has had a lot of successful Ph.D. students before you, is a good indicator of how they are as a supervisor. On the other hand, a small lab with a young supervisor can also be good. Working closely with a rising star in a field will mean that you get much more close attention from someone who is keen to make a big name for themselves and for whom being a Ph.D. student was a relatively recent experience. As a consequence, they may understand your perspective better than an older, more established scientist, so a small group with a relatively inexperienced supervisor can also be a very stimulating environment to do a Ph.D.

Before applying for a Ph.D. talk to as many people as you can about their own experience as a Ph.D. student and post-doc. Post-docs are particularly helpful if they have moved institute/lab since they can give you low down on what different people are like to work with. Most will be happy to explain to you what to look out for and what is good/bad. Some Ph.D. supervisors are excellent and work hard to give their students the best opportunities. Some others take less care, so you can find out some of this from talking to people - usually best done over a pint of beer or glass of wine!

When you have decided the places you might like to work, make sure you read the instructions on how to apply to each institution very carefully and follow them. It does not hurt to make a direct approach to a supervisor by email, but do make sure that you provide them with all relevant information. Remember though, that few potential supervisors will have funding of their own for a student. They will be competing for one of relatively few studentships awarded to their department. Potential supervisors will be most interested in what research projects you may have done already as well as your school and likely degree qualifications. Don’t send form-letter style emails to dozens of academics. Remember that most potential supervisors get inundated with applications by email from around the world. For example, I received around 150 from Oct 2007-Mar2008, so to get noticed, you need to make your application well written and informative and relevant to the supervisor’s interests. It does not hurt to contact a potential supervisor directly as well as applying through the university’s specified route, but keep your email short or better still phone them up. A short phone call can often find out more than an email that might get ignored. Do remember as explained above, that funding for non-UK citizens/residents to do a Ph.D. is difficult to find - if you are applying from India for example, look carefully at funding options that might exist for Indian students at the university you are applying to. Funding for non-UK students is scarce, so be prepared for disappointment.

Your first thought might be to stay where you are to do a Ph.D. If the option comes up with a supervisor who does work you are interested in, then you should certainly consider it, but also look at options elsewhere. At the very least, interviews at other institutes will give you an idea of what life is like somewhere else - maybe the project and environment will look better than the place you have already spent 3-4 years as an undergraduate. There are many advantages in moving institute for your Ph.D. You get to experience a different research culture, meet a different cross-section of scientists hear about different techniques and make many new contacts. In general moving is good and not too hard to do at the stage when most people don't have too many personal commitments like children.

Preparing for the interview

Ph.D. supervisors and their departments are keen to get the most able students. Good students mean good research is more likely to get done and so the supervisor's research goals will more likely be met and the department is likely to look better in RAE assessments (see below). You need to do your homework on your potential supervisor before the interview. Read any web pages they have, read a couple of their recent publications and try to get a feel for their career path. The more you know about your potential supervisor's work, the more likely you are to make a good impression at interview when you meet them. Interviews for Ph.D. positions vary enormously depending on the department and the supervisor. You might be asked to give a short talk about your undergraduate project. You will have time talking 1:1 with your potential supervisor. Some institutions require you to talk to more than one potential supervisor - this is to help them identify the best students since they will have more opinions about you. It is also a chance for you to learn more about work in areas that perhaps you had not considered. Remember that the potential supervisors will be selling themselves to you as much as you are selling yourself, so don't feel too intimidated by them! You should also have time when you visit the department to look around and to talk with current students and post-docs who work with the supervisor. If this isn't offered, then do ask! You can learn a lot about what he/she is really like as a supervisor by talking to students over lunch or a beer.

Being a Doctor

Once you have your Ph.D. it is normal in the UK to take the title *Doctor*. Confusingly, medical practitioners in the UK are also called "Doctor" even though they have not usually done any kind of doctoral degree, but instead have two bachelor's degrees (medicine and surgery). Doctor essentially means "learned", and in times past, medical practitioners were about the only learned people around, so had the title doctor. This courtesy is maintained to this day. Interestingly, in the UK (Male) surgeons take the title "Mr". I'm told this is for the historical reason that surgeons were originally barbers (people who cut hair) who were skilled with sharp tools and so were not "learned" people.

Once you have your Ph.D. you may wish to carry on in scientific research as a "post-doctoral research assistant". This is often shortened to PDRA , post-doc or postdoc.

Postdoctoral - What is a post-doc research assistantship?

The term *post-doc* usually refers to someone who has obtained a Ph.D. and is working as a research assistant (RA) on a project that is funded by a grant that has been won by a *principal investigator* (PI). Is that clear? Essentially, as a post-doc you will be working for someone else, on their project. You are constrained in what you do by the scope of the project, the supervisor's interests and whatever expectations the funding body has put on the grant. It is not quite as bad as that sounds. Post-doc positions are seen as training in addition to getting some research done, so the experience you gain as a post-doc is very important. It helps make you more marketable for the next job. Since research is unpredictable and driven by the talents of the person doing it (the post-doc) then in reality you will have a lot of freedom to get on with the research in a way you see fit. However, as with a Ph.D. position, it is important to choose your post-doc supervisor carefully if you want to have a happy time and obtain good publications. By the time you have your Ph.D. you should know who is good in the field and the labs around the world that you think would be interesting to work in. You will have worked all this out by seeing who publishes what, but also by word-of mouth from going to conferences and from your colleagues both senior and junior, and in particular, people in your own institute who may have previously worked in the labs you are considering. Many people move country for their first post-doc. For UK Ph.D. graduates, the traditional first job is often in a high-profile lab in the USA. Moving after your Ph.D. is nearly always a good idea as it allows you to apply the skills and knowledge you have acquired under the guidance of one supervisor in a different context. It also allows you to experience the different ways in which research labs can be run and will also expose you to research techniques that may not be available in your Ph.D. institution. Most importantly, it will give you a new network of scientific colleagues and friends that will stay with you for the rest of your career. As with Ph.D. supervisors, post-doc supervisors vary enormously in the freedom they allow their staff and the amount of career support they give you. However, all will expect you to work hard, do long hours, and be very self-motivated to tackle the problem you have been set.

What is a post-doc Fellowship?

The major difference between a fellowship and an assistantship is that a fellowship is awarded to the individual who is being paid by the award, rather than to their research supervisor. This has the advantage in that the project that you work on as a fellow can contain a much larger component of what you want to do, rather than what your supervisor and his/her granting body want. Having said this, as a post-doc fellow, you will not be an independent scientist, but will be working in someone else's lab and using their resources and expertise. As a consequence, it is in your interests to make the visit mutually beneficial by working on a project that you are both interested in and can contribute to and obtain joint publications. The advantage of a Fellowship is that in the unlikely event of things going badly wrong, you may be able to move to a different lab and take your funding with you. This would not be possible with a PDRA. Many countries run fellowship schemes to allow their best Ph.D. graduates to spend 2-3 years working in a top lab in a different country and many people come to the UK on this basis. What is available varies from country to country and the application requirements also vary. However, you will have to identify a lab that is willing to take you on. Then, together with the research supervisor at your chosen lab, you will have to write a research proposal. Typically, such fellowships are awarded based on your research record to date, the research standing of your proposed supervisor and his/her institution, what your referees say about you and your potential as a future independent scientist. Unfortunately, post-doc fellowships are pretty rare for UK citizens in the UK, so most people will do a PDRA or similar rather than get a fellowship at this stage of their career.

Beyond the post-doc.

The traditional career model for a scientist in a university is as outlined above: Ph.D., post-doc, lecturer, senior lecturer/reader, professor. However, it is hard for a scientist to combine building an internationally competitive research activity, with teaching high-quality courses to undergraduates, and carrying out administrative tasks. As a consequence, a more attractive career route is to secure an independent fellowship at one or more stages after the Ph.D. Independent fellowships usually free the holder from too many teaching or administrative tasks and so allow them to focus most of their energy on their research.

A post-doc fellowship as described above is an excellent first step, but most scientists will work as a PDRA for one or more periods before building a sufficiently strong publications list to apply for a more senior fellowship. Having worked as a post-doc for a few years, in one or more good labs, you should have a fair collection of first-author publications in good journals. At this point you should be well placed to apply for a fellowship. There are several organisations that offer fellowships that aim to support the best scientists at various stages of their career. Some are subject independent. An example is the Royal Society university research fellowship (URF). These fellowships pay your salary for up to 10 years and give minor research expenses (around £10K/year). RS URFs are awarded in all scientific disciplines, including engineering and mathematics. In contrast, some fellowships are targeted at researchers in a particular field. In biological research, particularly research associated with human disease, there are many possibilities. The Wellcome Trust, a biomedical research charity, has an especially well developed fellowship scheme. Their scheme includes, in order of increasing seniority: Career Development Fellowships (CDF,4-years), Senior Fellowships (SF, 5-years, renewable) and Principal Research Fellowships (PRF, 5-years renewable). The different fellowships are aimed at scientists at different stages of their career. CDFs are aimed at individuals with great promise to support them in their first position as an independent researcher. They provide the scientists salary and support for their research programme, which may include further salaries. SFs and PRFs are aimed at scientists with more experience and a stronger track-record and so accord higher levels of support. For details see the Wellcome Trust's web site. The medical research council (MRC) and Biotechnology and Biological Sciences Research Council (BBSRC) have similar fellowship schemes, but the eligibility details and subject scope vary. Cancer charities such as CRUK also have schemes as do charities that support research into other diseases. It is best to consult the web sites of all organisations that might fund a fellowship in your area and also talk to them about whether your plans/interests map onto their scheme. Writing fellowship applications takes a lot of effort, so you don't

Copyright © G. J. Barton, 2008

want to waste your time by applying to an organisation that simply does not support research in your area. For example, applying to the MRC for a fellowship to work on plant metabolism is likely to be unsuccessful unless there is a very clear application to human health and disease.

Choosing a place to do your Fellowship

The things you have to consider here are similar to those for a Ph.D. position or postdoc. In addition, it is wise to have a clear agreement with the department about the space the department will provide you with for a growing research group. Since you will be on a fixed-term fellowship you also need to get clear what longer-term commitment the department may or may not offer. It is usually good to go to a high-profile research department for your fellowship. In part, you will stand a better chance of getting the fellowship if you aim to hold it in a high-profile department, but also you will be exposed to many internationally competitive research colleagues. This should give you a good springboard into a more senior position when the fellowship ends, though you may have to move institute again to do this.

Moving moving moving

I have already pointed out some of the advantages of moving institute for your Ph.D. New environment, new techniques, new contacts. The same is true at all stages of your career and in particular when taking up an independent fellowship. It is hard to keep working in a field closely related to that of your last post-doc supervisor in their own department. Indeed, most organisations that award fellowships will encourage you to move away in order to give you the freedom to develop as an independent scientist. Some organisations will simply throw out fellowship applications that are to be held at the same institute. Of course, your last supervisor might very much want you to stay since you have been a brilliant post-doc and they have benefited a lot from your skills. However, you do have to look at what is best for your own career and usually this means moving. Smart supervisors will recognise this and help you with advice on how best to move and where good opportunities might lie. From their perspective, you could be a career-long collaborator even if you are competing with them in some areas.

Time in Industry

Should you take that attractive job in industry instead of doing a post-doc? Will it kill your future research career? This all depends on the subject, the industry and the type of job! There are very many eminent scientists who have spent time doing research in industry and then returned to academia. Equally, there are star scientists who have gone the other way and to first-rate research in industry. As with all career decisions, talk to people you know who have done both academic and industrial work and get their opinions and advice on any job you might be contemplating.

How do scientists publish their work?

As a scientist you do some original research work on some topic. This is usually very absorbing and interesting, it may take you months or years and you may discover something completely new about the system you are working on and so have made a contribution to the growth in human knowledge. However, if your work is to be taken seriously and remembered, you then have to tell other people about what you have done. The traditional way of doing this is to publish your work in an appropriate scientific journal. To get your work published, you first have to write it up as a *paper*. A paper is a document that describes the background, the methods used any results and discussion. Papers are also called *articles* and before publication are referred to as *manuscripts*. You then submit the paper (Strictly, we should call this a manuscript, but normally the term paper is used.) to an appropriate journal for them to consider for publication in that journal. There are many thousands of different journals that cater for different specialist areas as well as some more general journals that publish across all scientific disciplines. The exact format of the paper you submit, allowed lengths, number of figures etc, is dictated by the journal. Preparing a paper for publication is usually a LOT of work. Papers are short, but have to be written in a very clear and unambiguous style. “Creative writing” essay style that you learnt at school is no good. The work you have done has to be set in context with other work in your field, it must cite (reference) previous work and the interpretation of results must be rigorously explained. Once you have done all this, you can send the paper to an appropriate journal. The journal will have one or more editors. The editor will look at your paper and if it meets the general criteria for their journal will then send copies of it to at least 2 *referees* (also called *reviewers*). Some journals such as Nature and Science have quite a brutal sift on papers submitted, only a small proportion actually go to referees. Referees are scientists like you who work in a similar field and so can read, understand and make comments on the validity of your work. Once you have published a few papers, you will likely be asked to referee papers by other people in your subject area. The refereeing process is called *peer review*. The referees will read your paper carefully (you hope) and write a report that comments on the content and makes suggestions for improvements. The editor gets the referees’ comments and based on what they say will make a decision on whether the paper is acceptable for publication in the journal. Even if all the referees think your work is wonderful and the paper is clearly written, they may make suggestions for improvement. It is normal for referees to make suggestions, and the less they like the work, or the harder they found it to follow your arguments, the more suggestions they will make. Changes may be minor additions to the text, clarifications etc, or more major suggestions that more work is needed to justify the results and conclusions. Faced with the referees’ comments, the editor may then say that they will accept the paper subject to the changes being made. On the other hand they may reject the paper and suggest you send it to some other journal (any other journal but theirs!). A common reject statement is that “this paper would be better suited to a more specialised journal”. Of course, if you have just sent it to the specialised journal in your field, then this is probably telling you something else... If it is not an outright rejection, you read the referees’ comments, make the changes you agree with, then write back to the editor with the modified manuscript and an explanation of what you have changed and how. If there are things you think are unnecessary to change, then you have to explain this very carefully to the editor in your response. For some journals, the editor will then make a decision to accept based on your response. For other journals, and for more serious changes, the editor will send the modified paper back to the referees for further comment. On some occasions and with some referees, this can lead to another few pages of suggestions for changes and a paper might do several rounds of changes that are commented on by the referees before finally being accepted. Once accepted, your manuscript will go into production with the printers etc and you can refer to it as a manuscript *in press*. In the old days of publishing (pre 1999) quality journals would expend a lot of effort on cleaning up your text, improving your figures and diagrams and generally making the presentation of your work look more wonderful. Today (2008) most journals rely on the authors of the manuscript to get the details of presentation and language right, though the journal publishers will usually do the final page layout.

This system of publishing works quite well, but there are some problems with it. Referees are all busy people and your manuscript might take someone a day or more to read and digest properly and even longer for them to comment on. As a consequence, referees may not get around to reading the paper for weeks, and then might not do the best job they could. This might work in your favour if you have told a convincing and easy-to-follow story and have a strong track-record in the field. However, if your work is harder to present and you are not one of the "well known" people in the field, then it may work against you.

Referees are usually anonymous, and since the best referee is probably your biggest competitor, there is the possibility that they will be far more picky about the details of what you have done than is strictly necessary. In addition, some editors will sit on the fence and not make a decision, but send your revised manuscript back to the referees for further comments. This can lead to an endless cycle of suggested changes which can be very frustrating. However, as it is your manuscript, you can always tell the editor that you will withdraw the manuscript if they do not get off the fence and make a decision.

With the growth in the internet, publishing models are changing, but the idea of peer review is one that is still the mainstay of publishing scientific work in most research fields. In some subjects the primary way to publish is through *conference proceedings* rather than conventional journals. In those subjects (e.g. computer science), full papers are submitted to conferences, are refereed and then either accepted or rejected. If accepted, the author may be invited to give a talk on their work to the conference. In Biology, this is not usually the model. Biology conferences are made up predominantly by invited speakers, no full papers can be submitted, but abstracts of work can be submitted for "poster sessions". Poster sessions allow you to summarise a piece of work on an A0 sheet that you present in a session with dozens or hundreds of others. Delegates for the conference wander around and read the posters and discuss the work with you. Poster abstracts are not usually considered "publications" for the purposes of assessing a scientists' output, but are a valuable way to advertise work at an earlier stage of development that would be required for a paper. Some subject areas have pioneered the use of preprint archives. A preprint is the version of a paper before it is published in a conventional journal. In this publishing model, scientific papers are published to a repository of preprints that is accessible by the whole community. This makes work available for comment much more quickly than in the conventional publishing model outlined above. Although an important publication method in some branches of physics, this idea has not caught on widely in other subject areas.

How do scientists get funding to do their research?

All research requires people to do it, as well as equipment and consumables, not to mention space and electricity. People need to eat, so like to get paid for their work. As a consequence, all research takes money! So, where does funding for scientific research come from in the UK and how do you go about getting it? As an independent scientist (a PI - Principal Investigator), a lot of your time is spent finding ways to fund your research and maintaining continuity of staff in your research group. There is very little funding in the UK for long-term (i.e. to retirement age) appointments, just about everything is funded on short-term grants from one or more organisations. This presents an interesting and challenging problem for a PI, not to mention his/her staff. There are three main sources of funding: Government “Research Councils”, Charities and Industry. I will focus on Research Council and Charity funding since this is the most common source and the methods of applying are similar and follow an established pattern. Funding organisations offer different types of *grants* to support research. They include *project grants* that might fund a single post-doctoral researcher for three years, some equipment money, laboratory consumables and travel (so they can go to conferences, learn what else is going on in their field and tell people about what they have done) to work on a specific problem. Project grants can be bigger or longer, but 3-years and one post-doc is the norm, at least in biology-related subjects. Longer term funding is also possible and is often referred to as a “Programme Grant”. A programme grant may fund several post-doc researchers for 5 years. This allows the PI who holds a programme grant to try more ambitious research and to develop multiple themes in their research portfolio. Most successful PIs will hold multiple grants at any one time and from multiple organisations and will spend a fair proportion of their time juggling funds to enable people coming go the end of contract to keep working until the next grant starts.

So, how do you get a grant? First, you have to have a good idea! Then, you identify the funding agency that is most appropriate to approach. There may be specific calls for proposals in your area, or you may apply in *responsive mode*. Funding agencies appoint committees that specialise in different areas of science to assess grants and decide which will get funded, so you typically have to target one of these committees with your application. You then need to write the grant application. This will include a detailed costing for personnel, etc, as well as a detailed scientific case. The scientific case will include relevant background leading up to the proposed research as well as a description of what you are proposing to do. Space is usually limited to 5 pages for a three-year, single post-doc grant, so you have to be concise and clear in what you write. The application will also include sections to describe your scientific track record and previous relevant publications. Once everything is together, you submit the application to the funding agency in time for whatever deadline they work to. There is a lot of skill involved in writing grants - it is different to writing papers for publication. You have to present your past work and planned research in a way that is clear and appealing to someone who may not be an expert in your narrow field. This is a particularly big challenge.

What happens then? First, the office checks that you have included everything you should on the proposal and that your proposal is in the right area for their agency. Then, they send the proposal to up to 10 people for *peer review*. This is much the same as the system used for screening publications that I described above. Your peers write comments about the grant application and give it a grading. At the next committee meeting of the committee that your grant application will be assessed, your grant will be one of many, possibly 150 that are considered in 1-2 days by the committee. The committee consists of perhaps 20 people like you who are experts in some relevant area of science, plus the administrative staff of the funding agency and will be chaired by a scientist like you. Each committee member is given a set of grants to *speak to* and each grant will have two committee members who will speak to it. The committee members will have been sent all the grant applications and the referee reports in advance of the meeting and will have carefully read at least the applications that they are speaking to. Bear in mind that each member of the committee will have had to read around 10 grants in detail, so if your grant is not written clearly, they may miss the point of it. Committee members may also read other grants in the set if they have a particular interest in them and time to do it!

All committees work in different ways, but one common procedure is as follows: At the committee meeting, the grants are initially ranked by the scores given by referees. The committee quickly reviews low-scoring grants to check that the scores are fair, these grants are then eliminated. Any very high-scoring grants may also be put to one side as almost certain to be recommended for funding. The committee then spends most of its time discussing the rest of the proposals, which normally amounts to 80 or 90% of the proposals submitted. Discussion goes grant-by-grant. For each grant, the two people who have to speak to the grant take it in turn to summarise the grant and what they think of it given their understanding of the proposal and the comments of the referees. The wider committee then have the opportunity to comment/ask questions and generally discuss the merits of the proposal. At the end of discussion, a score will be assigned to the grant and it will be added to a preliminary ranking of all the grants. This is often done by one of the staff on a spreadsheet that is visible on a large screen. Once all the grants have been discussed and assigned scores, the ranking is re-examined by the committee to see if, now that all grants have been considered, that the ranking given to each grant is fair. Some re-organisation of scores can happen at this stage leading to a final ranking that is put forward. The precise cut-off for funding will vary from committee to committee and from meeting to meeting depending on the amount of money the agency has available to fund grants at that time. However, many good, high-ranked grants do not get funded, simply due to lack of funds. Most scientists get used to their very good grants being highly ranked, but not funded.

Is the system fair? At the committee, anyone who has a conflict of interest with the proposal being discussed has to leave the room while it is discussed. A conflict might be that their own application is being discussed, or that of a colleague at their own institution. The main problem is that most grants are potentially fundable, so the committee has a difficult job ranking them. A key component on the committee is who speaks to your grant. Their say can make a grant go up in rank or down.

How are scientists assessed?

Scientists are assessed by the quality of their research output. Research output is primarily regarded as peer reviewed publications, usually in scientific journals, though as explained in the section above, there are other ways of publishing work. What constitutes "quality"? In general this means being published in high-impact journals. A high-impact journal is one that is read by a lot of people and so includes a lot of articles that are cited by other articles. One measure of journal quality is to look at its *impact factor*. This is a number that reflects the number of citations that the journal receives. The simple view is that scientists that publish in journals that have high-impact are doing research that is widely respected. If you only publish in obscure, little read journals then your work is less regarded and so you are not such a good scientist. Unfortunately, this is a very simplistic view since some subject areas are not as trendy as others and so are less likely to appeal to high impact journals like *Nature* and *Science*. A further simplistic way to assess scientists is to count their total citations - how often do people cite their papers? If you work in a popular field, your citations are likely to be higher than if you work in a subject area that is less popular. This doesn't make your work any the less important, or your quality as a scientist less, but a pure numerical measure of quality based on citations might be unfair unless carefully normalised against citations within your field. In the UK every 5 years, there is a "Research Assessment Exercise (RAE)" for Higher Education Institutions (HEIs). The RAE process aims to assess scientists within the context of their field and so give a fairer estimate of quality. RAE is important in the UK since the results directly affect the funding given by central government to individual departments. So, if you are looking to move to a UK department to do research, look up its RAE score. Top research departments have a score of 5* (Five-Star). 5* departments will in general have better resources and research environment than departments with lower ratings. Of course, there might be individual researchers who are excellent in their field with international reputations, but work in departments that are not highly rated. You have to offset the benefits of working with such an individual against those of not being in a department that is rated highly overall. However, if you are keen to work with someone excellent who is in a poor department, then ask them how long they plan to stay there…

Prizes and Awards

Science prizes may be awarded by many different organisations to individuals who have particularly distinguished research records in the field that interests the prize-giving authority. As with any prize, who gets one depends not just on the quality of the individual, but also on the constitution of the prize committee and contemporary trends and interests in science. Prizes are good for the individual scientist, but also help to raise awareness of the field in which they work. This is particularly true of the Nobel Prize which can boost public awareness of an area of science and so help to channel public funds into that area.

Copyright © G. J. Barton, 2008

Finally

I started writing this document after explaining what scientific career options were available to one of my Ph.D. students. It was supposed to be a page of information about senior fellowships etc, but clearly has now gone much further! I hope that if you have read this far you will now be slightly more familiar with the mysteries of an academic career in UK science!

About the author

Geoff Barton is professor of bioinformatics and co-director of the post-genomics and molecular interactions centre at the RAE 5*-rated University of Dundee School of Life Sciences Research. He has published around 80 papers in peer-reviewed journals and is author of a number of software packages widely used in molecular biology research. He has supervised 10 Ph.D. students, and served on funding and review committees for several organisations. After a first degree in biochemistry from the University of Manchester, he did Ph.D. research funded by the SERC (Science and Engineering Research Council) at Birkbeck College, University of London. He then held an ICRF post-doctoral fellowship at the Imperial Cancer Research Fund Laboratories in London, before being awarded a Royal Society University Research Fellowship to establish his research group at the University of Oxford. Before taking up his current position at Dundee, he was research team leader head of the European Macromolecular Structure Database at the European Bioinformatics Institute, Hinxton, Cambridge.

Copyright © G. J. Barton, 2008