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

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Prefaces

Version 4.0 – July 2018

It is now ten years since I wrote the first version of this document. Back in 2008 there were relatively few options for publication on the web, so I just put the PDF on my website (www.compbio.dundee.ac.uk) in the hope that Google would index it and people would find it. This seems to have worked to some extent – I just looked at the logs and see that the different versions of this document have been downloaded over 100,000 times in 10 years and over 20,000 times in 2017 from my site alone! Unfortunately, most of the time they are downloading Version 1.0 which is why, with this version I am naming it the same as Version 1.0. If you want old versions then please follow the links below.

Many people have written to me or told me in person that they have found this document helpful in explaining the mysteries of the UK system. Several have encouraged me to publish it somewhere else that is more visible. Unfortunately, it is not obvious to me where to publish a document like this – if you have ideas and suggestions, then please let me know!

There are lots of changes and additions in this version. I've fixed text and updated throughout, but also added a new section on the career options for people who do not follow "standard" progression from Ph.D. to PI/professor… This is a tricky area so hopefully will be helpful for those navigating a career in UK academia. I've also added a lot of new material on Ph.D. funding, how to choose a university for a Ph.D., more details on career to a PI position and what it takes to keep doing it, more about preprints and their role in publishing, more on grants and grant applicant status, Co-I/PI, RCo-I and what they mean and why.

www.compbio.dundee.ac.uk/ftp/pdf/The_UK_Academic_system.pdf

Version 3.0 – March 2014

I've updated a few sections including the bit on salaries, and also added a few general tips on preparing for interviews. Note that the previous URL for this version now points to the latest version of the document above. If you wish to access Version 3.0 see the URL below.

www.compbio.dundee.ac.uk/ftp/pdf/The UK Academic System_V3.0_March2014_3.pdf

Version 2.0 – April 2012

In this version I've added new material on what a University is and the meaning of the words School, Faculty and so on. I've also tidied up some of the text and updated details on research assessment and fellowships and added a contents page. I hope that this new version is useful to anyone interested in how UK science careers work and what scientists do in Academia. Do please email me and let me know if you find the document helpful! Note that the previous URL for this version now points to the latest version of the document above. If you wish to access Version 3.0 see the URL below.

www.compbio.dundee.ac.uk/ft/pdf/ The UK Academic system_V2.0_April2013_2.pdf

Version 1.0 – March 2008

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 those reading this find it helpful in navigating the mysteries of a career in academic research in the UK.

Note that the previous URL for this version now points to the latest version of the document above. If you wish to access Version 1.0 see the URL below.

www.compbio.dundee.ac.uk/ftp/pdf/The_UK_Academic_system_1.pdf

Introduction

In this article, I give an overview of the career path for a research-active scientist in academia in the United Kingdom (UK), from school at 18 years old (see later for definitions of "School" in the UK), to a senior academic research appointment. I also explore some of the options for those who do not follow this career path but do wish to stay within the UK academic research environment. 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 (i.e. jobs in a university), 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. The document is based on my personal experience of the Universities of London, Oxford, Cambridge and Dundee, but also from working in research institutes and many discussions with friends and colleagues across numerous UK research-active institutions. 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, 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 to Blue Skies Research, "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

An academic scientist's research environment

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.

What is School, University and all that?

You say the word *School* to most people in the UK and they will understand you to mean the education system you go to from the age of four or five to sixteen or eighteen years old. At eighteen you might go to a *Higher Education Institute (HEI)*. Most of these today, are known as *Universities* due to UK-wide organisational changes in 1993, but before then, the UK also had *Polytechnics* and a large number of *Technical Colleges* as well. As a consequence, you may hear people refer to "pre-1993" institutions to distinguish an older University. I'll come back the essential differences between Universities later in this document. At University you study for one or more *Degree,* so this article starts with a brief mention of how you get from School to University then goes on from there!

In the UK we find it slightly funny when people from the USA say something along the lines of "I went to school at Harvard/MIT/Purdue/UCSD etc…" since in the UK school is what you do from age 5-18 at which point if you are lucky, academically talented and work hard, you *leave* school and go to University! However, the creep of culture from the USA pervades everything, so Facebook turns all users' valued time at University into time at "School". This is annoying, but I suppose we have to live with it.

Of course, these definitions of school and university are not complete. The word *school* is also often used in the UK to define parts of a university, as are the words *Faculty, Division, Department* and *College.* Different universities in the UK apply these words in different ways to describe different parts of their organisation. For example, at the University of Dundee we are currently organised into nine *Schools* (I am in the School of Life Sciences) and within each school there are either *Divisions* or *Units*. Confusingly, until a few years ago, here in Dundee we were organised into four *Colleges* each of which had a number of schools in it! Given that my university goes through organisational and naming changes like this, it is not surprising that other universities use similar names that can define completely different groupings at different levels in the hierarchy! For example, the University of Oxford uses the term *Division* at the top level to define four broad subject areas (equivalent to what Dundee used to call colleges) and then each division has multiple departments, units or even more confusingly; Divisions… Somewhere over the last 10 years the word *Faculty* has fallen out of favour in the UK to describe subject areas (For example, the University of Dundee used to have a *Faculty of Science and Engineering*, which included departments of Biochemistry, Anatomy and so on…). Suffice to say that the only way to understand what grouping someone belongs to in a university is to go to the web page of that university and figure it out from there. The reasons for this confusion of names are many and varied, but we just have to live with it!

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 primarily 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 normally 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 5 or more subjects studied to 17, exams sat (Highers), and then the option of studying for more exams "Advanced Highers" over a year. Students who have studied A-levels or "Advanced Highers" and got excellent grades often have the option of entering a Scottish University undergraduate course 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. Like most old and established systems, what I describe below is evolving so I will try to point out some of the changes happening as I go along. What I describe here is a general overview based on my own experience and should apply to most UK institutions. Where I know about differences I'll point them out, but 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 in a later version of this document.

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 post-Ph.D. hierarchy

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

Traditionally, university academic staff have three jobs: They do original research, they teach, and they perform administration. Increasingly, in the more successful research-active departments (at least in life sciences), 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.

Lecturer

A *lecturer* is the most junior traditional independent position. In this context, *independent* means you define your own research programme. Scientists who define their own research programme are sometimes called *group leaders,* or *principal investigators (PIs)*.

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 3-6 years as a post-doc before taking up the lectureship.

In the USA I think lecturer is probably equivalent to an *associate professor* position.

I understand that the job title "Lecturer" also exists in the USA and is not equivalent to a UK University Lecturer. In order to avoid confusion over their status, some of my colleagues in Dundee who are lecturers make a point of explaining on their web page or email signature that lecturer means "assistant/associate professor". Presumably for the same reason, the University of Oxford has gone a stage further and has renamed all its "Lecturer" equivalent staff "Assistant/Associate Professor" or "Professor". Still, as an ancient institution, Oxford has some other unusual names for staff. For example, at one of the Colleges in Oxford, its senior "faculty" were (maybe still are) called "Students"…

Senior Lecturer

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.

Reader

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

All positions from Research Assistant (see below) up to reader/senior lecturer are usually paid on a UK nationally agreed pay spine. If you are on one of these pay spines, then you received an increment in pay each year up to some maximum for that pay grade. I'll come back to the subject of pay and contracts later in this document.

Professor

The most senior academic job title in the UK is *professor*. Most departments or other groupings will have only a few professors but more lecturers, senior lecturers and readers. 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 completely different! 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.

Some UK Universities have different "grades" of professor. I know of one that has three grade bands, so if you are being considered for a chair somewhere it would be worth asking if this is the case at the university you are applying to. Professorial grades like this aren't titles that are usually advertised but are internal salary scales used by the university for promotion purposes. It is hard to figure out the salary range for professors at a particular university, this information is rarely if ever public, and in the UK it is unusual for people to divulge their salary to others. Indeed, it is generally considered bad manners either to ask someone what they get paid or to tell someone.

The University of Oxford has an unusual type of professor known as a *titular professor*. Titular professors were introduced in the 1990s as a way to "promote" someone without actually giving them any more money. This sounds pretty weird, but Oxford at the time had a lot of staff with international reputations that would mean they were of sufficient standing to be a full professor anywhere else but were just called "lecturer" at Oxford. The promotions process was similar to that at other institutions and if successful the candidate could use the title professor. As I mentioned above, I believe that Oxford has now eliminated the title "lecturer" completely, so I guess they still do this.

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 particular skills. Professors are normally the people who hold the most senior positions within a department (faculty, division, school, college etc. – see above) and set the steer for a department's direction.

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

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. Some institutions such as Oxford, use the title "BA" for all Bachelor's degrees irrespective of whether it is in a Science or Arts subject. Bachelor's degrees take either 3 or 4 years to complete. Now it gets complicated since there are differences between England/Wales and Scotland. In England/Wales the traditional Bachelor's degree takes three years to complete. In Scotland, it is four years since it is possible to start University at the age of 17 after obtaining Scottish "Higher" exams. As such, the first year of Scottish degree courses is a kind of foundation year for the degree that teaches a lot of what might be in the second year of a school A-level course, or a Scottish Advanced Higher course.

Some undergraduate degree courses in England/Wales add a fourth year and in Scotland a fifth year, which is usually optional and selective and leads to a "Masters" degree in the same subject. Students can graduate with a BSc Hons or stay the extra year and graduate with a Masters as well.

Even more confusing is that some traditional degrees incorporate an extra year in industry or other activities in one of the years, usually before the final year. Really, if you are thinking about studying at undergraduate level in the UK you have to explore all these options in the prospectus for the courses you are interested in and be aware of the different options.

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* (2:1) and *lower* (2:2) divisions. The distinction between the two second classes of degree is very important. Employers and a funding organisations for higher degrees will often require that you have obtained a First or Upper Second-class (2:1) degree and may not even consider you for interview if you don't. It is hard but sometimes possible to rescue things if you get a 2:2 degree as I will explain below.

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* (Incidentally, in the UK you don't "graduate" from school at 16 or 18, you just "leave school".). 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.

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 normally 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 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. Remember that not all UK Universities are equal, some are institutions that focus mainly on teaching vocational courses and have very limited research activities. These are not usually good places to do a masters since you won't be taught by research active staff and will have little exposure to current research in the field. Clearly though, 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, though increasingly this is necessary to help distinguish candidates. Candidates with a masters degree will normally have more research experience than someone fresh out of a bachelor's degree and so be better placed to start a Ph.D. research programme. The traditional UK Ph.D. (Doctor of Philosophy. At Oxford University, 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 aids 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.
Although the traditional Ph.D. programme is three years, increasingly, Ph.D. courses in the UK are four years. The structure of four-year courses varies from place to place and funding agency to funding agency but often the first year will involve research "rotations" through different laboratories. For example, at Dundee one of the Ph.D. programmes is funded by the Wellcome Trust and students in their first year do three rotations as well as some courses. After each rotation they write up the project and give a presentation on it. At the end of the year they choose a lab to spend the next three years in doing their Ph.D. project full-time. 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.

Assessment and support during the Ph.D.

In most institutions, there is a critical assessment of how things are going at the end of the first full year of working on your main project. This would be at the end of the first year in a three-year programme or the end of the second year in a four-year programme that had rotations in the first year. Normally, students are expected to write a full report on their first year's work as well as write a plan about how they will develop the ideas in subsequent years. The student will often have to give a short talk about their project and also be examined by academics who are not involved in their project in a "mini-viva". This gives the student experience of writing and presentation at an early stage of the Ph.D. as well as a flavour of what a viva will be like. This process is often called the "Ph.D. transfer" since it is only after passing that the student is considered a Ph.D. student. The exact mechanism of this transfer varies from institute to institute, but it is an important cutoff point both for the student and the institution/supervisor. Once you are through the first-year transfer, then the only other assessment is the final Ph.D. viva.

Most institutes provide strong support for their Ph.D. students in many ways. For example, at Dundee Life Sciences, one of the support features is that every student is a member of a "Thesis Committee". This is made up of two academics who supervise students but are not involved in the student's work and meets three times a year with the student to discuss their work and progress. It is an extra contact point for the student to get advice and in extreme cases, for example, if there is a dispute between supervisor and student, to help resolve the issue. In the final year, the thesis committee can give helpful advice on thesis writing and job hunts and provide extra expertise/contacts over and above those already provided by the supervisor.

Write thesis or write papers?

As a research scientist, there is always more work you could do on a project. More experiments, more analysis and so on to understand the system you are studying. However, it is impossible in three-years to do everything you might want to do, so you have to stop at some point and write the thesis. There is often tension between writing papers which are important for your career development and that of your supervisor (see below) and writing up your thesis and submitting it for examination. If you are lucky in your work, get good results and learn to write scientific papers quickly, you may well have research publications published during your Ph.D.. If you can do this, it is fantastic and makes writing up your Ph.D. thesis much easier as, assuming the publications are predominantly your work, you can adapt each publication into chapters in your thesis.

In the past, it was fairly common in the UK for Ph.D. students to write papers first, then perhaps spend an extra year or so finishing off and submitting a Ph.D. thesis. This was always a bad idea as you need to have submitted the Ph.D. to move on to another lab/job as a post-doc. Today, most Ph.D. programme funders insist that Ph.D. students they fund submit within four years of starting. If a department has a record of students not submitting in four years, it is considered negatively for future funding to that department. Accordingly, Ph.D. students now focus on completing their Ph.D. thesis and submitting it within the four years, then perhaps stay on in the lab for a few months to finish off relevant work and write up papers for publication.

The need to submit in four years focuses the mind of both the Ph.D. student and their supervisor!

The Ph.D. Exam (viva)

Once the Ph.D. thesis has been submitted to the university, two examiners will be selected. How examiners are selected does vary a bit from place to place, but typically, the Ph.D. supervisor or colleague will approach people in the field that they think would have the right expertise and experience to examine the student's work. 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 (or require them to – e.g. at the University of Birmingham), but in my experience of being external examiner for around 30 Ph.D. theses, this is rare at UK universities.

Overall, the purpose of the viva is to make sure that the work reported in the thesis is the candidate's and that it meets the standard suitable for the award of a Ph.D. degree. 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; accept after major corrections and a second viva; award an MRes; Fail. It is normally the internal examiner's job to check 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 and up to a year for major corrections. However, it is always best to do them as quickly as possible.

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 or EU citizens. 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.

Ph.D. funding for living costs is usually in the form of a *stipend* rather than a salary and so is not subject to UK income tax. This means that you cannot directly compare the amount of money you will be given as a student to what you might earn in a "normal" job. Since tax is not taken off, some of the more generous Ph.D. funding schemes such as those from the Wellcome Trust provide the student with income that is comparable to starting a post-doc job!

Of course, if you have the funds to pay your own living costs, fees and laboratory costs, then you will be interesting to potential supervisors. However, you will still need to be accepted on academic grounds as suitable to carry out a Ph.D. at that institution.

Finally, it is also possible to carry out research towards a Ph.D. while doing another job. For example, you might already be working as a Research Assistant or Technician in a university laboratory, but then register for a Ph.D. so that your research work can count towards a Ph.D. This is pretty rare today as a way to fund a Ph.D. since it can lead to conflicts between the need of your job to support other people and the needs of your own Ph.D. research work. Accordingly, it requires a clear understanding between your supervisor, you and the university about how it will be managed. For example, can you work full-time on your Ph.D. project or will you have to devote a proportion of your time to other things? Financially, you may be paid more as an RA than you would as a Ph.D. student, but you would likely have to pay your own university fees for the Ph.D.. If you are going this route, then it will be something that is worked out on a case-by-case basis and is not widely used as a way to fund a Ph.D. in the UK.

How to choose which University to go to for a research degree

As I mentioned above (What is School, University and all that?), institutions where you might do a research degree (Ph.D.) are all called *Higher Education Institutes (HEIs)* but vary in their scope and research activities. There is a subset of UK Universities known as the "Russell Group" that are highlighted as institutions with a strong research focus. You might think that it would be a mistake to look anywhere else for your Ph.D. but this could not be further from the truth! Russell Group universities tend to be the larger universities in the UK and provide research opportunities across a wide range of sciences and non-science subject areas. Non Russell Group universities may have very strong research activities, but only in a narrow range of subjects and so still be excellent places to carry out research for a Ph.D.. For example, the University of Dundee where I now work is not Russell Group, but our School of Life Sciences is one of the largest in the UK and was rated the top life sciences university research department in the UK by the UK Government in 2014, ahead of much bigger universities like Oxford, Cambridge, Imperial and UCL.

In order to select a University, you should really focus first on the research area and supervisor options as I explain in how to choose a Ph.D. supervisor below. If you intend to pursue a research career, then future employers should look at what you have done, which papers you have published and so on, rather than where you did your degrees. However, there can be fringe benefits in attending one of the very well-known UK universities at some point in your career. Firstly, you may meet a broader range of people with different interests and skills at a big university. Big universities will have a lot of external, high-profile visitors across many subject areas who will give seminars and you may have the opportunity to meet. Equipment vendors and potential employers may also focus attention on such universities.

A further benefit that is harder to measure is "brand identity" that comes down to human nature and unconscious bias. If you travel anywhere in the world and say: "I work at the University of Oxford", most people will have heard of it and recognise it as a centre of excellence. This at least gets people listening to you, though it is then up to you to convince them that you really do know what you are talking about! A well-recognised brand can also help on a CV for a job outside your specialist area. The Oxford/Cambridge/Imperial etc "brand" may help you to get the interview since the assumption is that you will be of a certain standard because you studied or worked there. Some employers outside science will value these brands and use them to suggest that they have excellent staff even though working at a big-name university does not guarantee the individual is excellent!

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 person who is 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 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 are likely to get 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 the 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 in the UK 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-Mar 2008, 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. 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 often not too hard to do at the stage in life when most people don't have too many personal commitments.

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/REF 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 may have time talking 1:1 with your potential supervisor, but for many Ph.D. programmes you will just be interviewed by committee. 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 might also be given 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 potential supervisors are like by talking to students over lunch or a beer but it is unfortunate that this kind of informal contact is now becoming very rare in Ph.D. interview visits.

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. You will also have met many potential supervisors at international meetings or perhaps when they visited your institution to give a seminar. Many people move to a new 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.

For the sake of completeness I should add that although most research assistants (RAs) are post-docs (PDRAs), some are RAs without a Ph.D.. Such positions tend to be a bit unusual in my experience but can sometimes be a route to a Ph.D. as explained in Ph.D. Funding above.

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.

Applying for a post-doc position and preparing for interview

I made a few comments above about preparing for a Ph.D. interview, but I think it is worth reiterating here since in my experience candidates for post-doc positions often do not prepare well.

Make sure you do your homework, not only on the potential supervisor but also on the institution, town/city and country in which the job would be held. You probably already know a lot about the supervisor's work if it is a field you have been working in for your Ph.D. or an earlier postdoc, but if not, then you have to read up on it in detail. Your potential supervisor will think their work is the most important and interesting in the world – they will expect you to have the same enthusiasm for it! If this does not come across in the interview, then you will not excite the person interviewing you and so you will reduce your chances that they will want to take you on.

Indeed, if you are not enthusiastic and interested enough in the work the potential supervisor does to read up about it in detail, then you have to wonder why you are applying for the job in the first place!

In your covering letter for the application, make sure you write specifically about the job you are applying for, why you are interested in it and why you think it would be a great opportunity for you. Spell out the skills and experience that you would bring to the project. Yes, some of this might be in your CV, but the covering letter is your opportunity to emphasise the most important points that are relevant to the specific job you are applying for.

I have screened probably thousands of applications in my career. A significant proportion either have no covering letter, have a very short letter, or have a generic covering letter that is not specific to the job. The worst ones refer to a different institution, just to make it crystal clear to the person reading the letter that the applicant is applying to many places and not really thinking about what each job is asking for!

As you can read below (in How do scientists get funding to do their research?) the person advertising the job has gone to a lot of trouble to win the funding for the position they are advertising. You should take the time to make your application as clear and strong and specific as you can.

The ability to communicate your research to a new audience through a presentation is a key skill that all researchers need, so at a post-doc interview you will usually be expected to give a talk about your research and to answer questions. This might just be to the potential supervisor's research group or to a wider audience. Often this will be a short talk, so prepare well. Preparing a short talk is much harder than a long presentation, so allow a lot of time to get this right. Give your talk to other people and get comments from them on your style and clarity. Tell them the kind of job you are applying for so that they can help you to "tune" the talk to the audience and the job.

Beyond the post-doc – getting to PI

I'll first deal with the path you might follow from post-doc to running your own independent research group, then I'll look at alternative careers in the UK academic system. The traditional career model for a scientist in a university is as outlined above (in Academic Career in Summary): 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 that would allow you to become a Principal Investigator (PI) and run your own group. 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 when I had mine in the 1990s!). 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 up to date 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 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 hosting you 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. Some fellowship schemes explicitly require a commitment from the host university to a proportion of your salary in later years with the intention that they will employ you at the end as a lecturer/reader/professor.

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 – or not?

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 normally it is considered essential when taking up an independent fellowship. This is because it can be hard to keep working in a field closely related to that of your last post-doc supervisor in their own department. Indeed, until recently, most organisations that award fellowships would encourage you to move away in order to give you the freedom to develop as an independent scientist. Of course, your last supervisor might very much want you to stay since you have been a brilliant post-doc and they have benefitted a lot from your skills. However, you do have to look at what is best for your own career and often 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. Of course, sometimes the very best place in the world to continue your independent career is exactly where you are. Perhaps it has the best specialist facilities, equipment and support expertise for what you do which might be very hard to replicate anywhere else. Perhaps your mentor(s) are close to retiring from science and see you as a worthy successor in a few years' time. Suffice to say, wherever you choose to develop your independent career, it is vitally important to have the strong support of the host institution to your fellowship and ideally a clear path to a tenured position later.

There are big challenges for anyone trying to build a career towards a PI position and balancing this kind of job with other aspects of life. I may discuss this in a later section or version of this document!

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.

What is "Tenure"? Towards the "permanent" job…

As a scientist developing your career you will spend some time on fixed-term contracts or at least fixed-term funding. This means your job is not secure beyond the term of the contract or the funding. Naturally, this is an uncomfortable position to be in. If you start a 3-year post-doc position, then towards the end of the second year, you really need to be looking at where your next job will be! Depending on your attitude to risk and certainty, this can make developing your life outside work difficult. You may have to move to secure the next job and if you have a partner with a career of their own, children or other dependents it can be difficult to uproot every few years to shift to a different city or even country. Indeed, you might just like where you are living and so not want to move!

Traditionally, "Tenure" meant a job for life. In fact, if you had a tenured academic position, then it would be almost impossible for you to lose your job, even if you did absolutely nothing! Today, the reality in the UK is that there is no such thing as a permanent tenured job. No job is guaranteed for life, but some jobs have much greater job security than others. A job as a university academic; a lecturer, senior lecturer, reader or professor, or similar; is often regarded as "permanent" since the funding for the job is secured by the university and the contract you have will normally end on retirement. It does not mean that you cannot lose your job, sometimes universities need to change their priorities and so perhaps not need your skills or discipline any more, but it is certainly one of the securest jobs you can have.

While you might not have a permanent job while paid off a grant or fellowship, if there is guaranteed grant funding, say for 5-years, you may have a more secure job than someone in industry who could be made redundant (sacked) with only three-months' notice or less.

What does it take to be a Principal Investigator?

I've described the basic steps towards becoming a tenured academic, or at least a Principal Investigator on long-term funding at a UK institution. Some people start out a Ph.D. on the assumption that the natural progression to a PI will "just happen" for them, that their brilliance and ability will be recognised and rewarded with a job like their Ph.D. supervisor's. However, achieving the status of PI in UK academia requires tenacity and planning. It is usually hard to do and maintaining a research career once you have got to run your own group is also challenging.

This is it in summary:

1. Do Ph.D. in good lab and write lots of first-author papers. These are publications where you have taken the lead on the ideas, doing the work and writing it up.
2. Do postdoc in different good lab and write lots of first-author papers
3. Maybe do another postdoc that allows you to refine your own ideas for future research that are different from your Ph.D. or postdoc supervisors
4. Identify great place to hold an independent fellowship
5. Work with that great place to write and win said fellowship
6. Win fellowship, move to new place hopefully with great mentoring support, set up lab, learn how to run group/supervise Ph.D. students, learn how to write and win more grants, learn how to supervise/work with post-docs, continue to publish great science
7. Win tenure at great place or move to another great place that recognises your talents better!
8. Continue to build scientific reputation/attract talented students and postdocs to work with you
9. Learn how to help different people along different career paths - not everyone wants to be or is cut out to be an academic PI
10. Try to keep it going while recognising that the output of your lab is a team effort that is dependent on the talents of individuals
11. Battle with the challenge of supporting the careers of your students and postdocs while also maintaining continuity of expertise in your team
12. And last but not least. Do all the above while maintaining a good work/life balance!

To achieve all this, you need to be fairly single-minded about your own work. You have to make sure you write up the work you have done in a timely manner. Writing and submitting papers is time consuming and can be very frustrating but it is critical to demonstrating your contribution to science. You also have to learn to appreciate and support the work of others in your group and wider field while competing internationally with them for recognition and nationally for funding. Suffice to say that not everyone who starts a Ph.D. wants to do this or has the temperament for it.

Staying research without following the PI path

This document was originally focused on explaining the basic hierarchy in UK academia. However, it is clear that not everyone will follow this path after starting out as a Ph.D. student. At various stages, scientists may leave academia to pursue alternative careers. There are many options open to someone who has learnt the skills necessary to organise themselves to do research and to present their work in written and oral forms. These skills are highly transferrable as are skills in statistics and data analysis that you might also gain in a modern biology lab. Accordingly, a Ph.D. can be great training and for a wide range of non-research careers.

However, leaving academia and changing direction to something else is a hard decision to make. You might be a post-doc in a great lab, get on well with your PI and enjoy the dynamic of their group. With your help your PI may continue to win competitive grants to continue doing research that you have contributed to. It is fun being where you are and doing what you do. You put down roots in the city/region and so it becomes harder to move elsewhere. Before long, you may find yourself on your third set of post-doc funding in the same group and you have become the backbone of the group. You train new group members and are key to the group's success. You make it possible for the PI to spend time pushing the group's work in new directions and advertising the group's work around the world at the many high profile talks they are invited to give.

Almost every larger successful research group I know has at least one senior, skilled researcher like this in the group. They maintain continuity of expertise, specialist techniques and so on and the group won't function as well without them. If you have not made the decision to drive your own independent research career, then it can be a great alternative career to stay where you are with a successful PI and contribute to making the group even better! The main drawbacks to such a career are the lack of perceived job security and the lack of salary progression once you hit the top of standard salary scales for research assistants. A further drawback is that there is no formal recognition of senior post-doc positions, nor career structure for non-PI-track scientists in the UK university system. This boils down to the sources of funding for research scientists in academia.

In UK universities, there are really only two kinds of job: 1. those that are underwritten by the University and 2. those that are not. For 1., regardless of where the funding comes from to pay the individual, if the role is still needed by the university, then they will keep funding it. For 2. the job is linked to the funding, if the project has ended the need for the job has gone. Most lecturers, professors etc fit into 1. but others also fit this type of underwritten role. Scientists that support core resources (mass spectrometry, sequencing facilities etc) often fall into this group, but creating new positions like this requires a financial commitment from the University to the role. Core facilities are important to the whole organisation and so an institution may be well disposed to supporting some key staff in this way. The problem though comes with people who perform a similar core role for an individual research group rather than the whole organisation. Funding research groups is the responsibility of the individual PI. They do this by winning external grants which are subject to the requirements of each funding organisation. A successful PI will have to juggle multiple grants to keep everyone in their group in a job. Someone may come into a group like this as a postdoc and stay because the science is interesting and the PI is successful with their help in getting new grants.

If you want to keep doing scientific research in a UK university, but don't want to go the full PI path then there are really only two options: 1. Stay as a post-doc and accept that your salary options are limited and job security is down to grant success, or 2. Make yourself indispensible as the manager of a core facility.

Personally, I think there should be a recognised career path for people who wish to be scientists but not PIs. However, for such a career to work, universities have to take the decision to fund such positions. As I say above, there can be a good case for this when the person interacts with many research groups and/or contributes to teaching and training. It is harder for a university to justify such an appointment when it will only benefit one research group. Some universities do have job titles that run a parallel career path to lecturer, reader, professor and so on, but while these titles give status to the senior post-doc in a group, they are rarely linked to institutional funding.

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.

When the editor receives the referees' comments they will take this into consideration before making 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. This can be a very frustrating process for an author, particularly if a referee appears to be ignoring the reasons why you are not applying every one of their suggestions. It is also frustrating when an editor leaves all the decision making to the referees rather than making up their own mind about the paper given what referees and authors say.

Once accepted by the journal, 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, 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 can 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. Refereeing a paper gives the referee privileged access to unpublished data and ideas; in an ideal world such knowledge should not affect the referees' behaviour. However, it is thought that some referees either consciously or unconsciously abuse this knowledge to give themselves an advantage in publishing their own competing work. 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.

Despite the time that responding to referees' comments takes, it is my experience that the version of papers that is finally accepted for publication is always better after refereeing than before. Having many experienced people read and comment on your work inevitably helps improve it, even if the improvement does not alter the underlying science, but ensures clarity of presentation. A referee who has not been involved in your study will see the research with a different perspective and so notice explanations that are missing or unclear as well as perhaps identify more fundamental flaws in your reasoning that you would like to fix. It is a universal rule that human activities improve through cooperation, and communicating scientific research through written publications is no different in this respect.

Conferences – Abstracts and posters

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.

Preprints

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. The arXiv preprint archive in Physics has long been regarded as the definitive place to go to read the latest breaking research. In biology, this idea got off to a slow start but now (in 2018) many scientists deposit their new work in biology to the bioRxiv preprint archive run by Cold Spring Harbor Laboratories. In the publishing model that includes a preprint you submit the manuscript to the bioRxiv archive at the same time as you submit to a conventional journal. The bioRxiv version of the manuscript is available for anyone to read within a day of submission. It has a DOI number and can be referenced in other papers while you attempt to publish the work through full peer review in a conventional journal. Depositing your manuscript on a preprint archive like bioRxiv has the advantage of showing the world that you have done the work and so can set precedence in the field. In the UK preprints deposited to bioRxiv and other servers are now accepted as "outputs" in grant and fellowship applications to most major funding organisations.

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 and have somewhere to live, 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 their 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 to the end of funding to keep working until the next grant starts.

So, how do you get a grant? Firstly, you have to have a good idea! Then, you have to find the most appropriate funding agency that you are eligible to apply to. The rules on eligibility vary from funding agency to agency, but a core feature is always that your own job as applicant will last longer than the funding you are asking for. This makes sense, since if your own job disappears, how can you direct the research project? What this means in practice is that if you are on a fixed-term contract, or funded from external grants yourself, you are unlikely to be eligible unless your university will guarantee your job for the duration of the grant.

Grants will usually have only one PI listed but may have several Co-Investigators or Co-Is listed. Co-Is are usually academics with complementary skills to the PI who will collaborate on the project and co-supervise any staff employed on the grant.

There may be specific calls for proposals in your research 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.

Usually the biggest cost on a grant is the staff salaries. When you write the grant you might name a specific individual who would be appointed to a post-doc RA position or technician position if the grant was funded. While you can't normally be a Co-I as a postdoc even if you have contributed a lot to writing the grant, the BBSRC, EPSRC and more recently, MRC have the category of "Researcher Co-Investigator". RCo-Is are Research Assistants who will be paid off the grant but have contributed to developing the ideas in the grant and writing it. Being an RCo-I gives you some status in the application, it gives experience of grant writing and can also look good on your CV when you are perhaps applying later for your own independent fellowship or other research job.

What happens then? First, the funding agency 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 opinion 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. However, 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 most recent RAE exercise which finished in 2014 was renamed REF and gives slightly different outputs, but overall the system is similar. The RAE process aims to assess scientists within the context of their field and so give a fairer estimate of quality. RAE/REF 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 how well it did in past RAE exercises and REF. Top research departments had a score of 5* (Five-Star) in RAE and will have been ranked against other departments in REF. 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. There are also prestigious *Fellowships* of professional organisations. The highest of these in the UK is *Fellow of the Royal Society (FRS)*. Many other professional bodies have systems for awarding the title of *Fellow* to a scientist and this normally means the scientist has satisfied peers in their field that are already Fellows that their research is of a high standard. I may well expand this discussion in a future version of this article!

Finally…

I can't quite believe it is 10 years since I wrote the first version of this document, nor that it has grown to over 30 pages! If you read any of this and find it useful, then please do let me know!

About the author

Geoff Barton is currently professor of bioinformatics and Head of the Research Division of Computational Biology at the University of Dundee School of Life Sciences. He is a Fellow of the Royal Society of Biology, has published over 130 papers in peer-reviewed journals and is author of a number of software packages widely used in molecular biology research. He has supervised 17 Ph.D. students, and served on funding and review committees for many 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 (Now called Cancer Research UK.) in London, before being awarded a Royal Society University Research Fellowship to establish his own research group at the University of Oxford. Before taking up his current position at Dundee in 2001, he was research team leader and head of the European Macromolecular Structure Database (now known as PDBe) at the European Bioinformatics Institute, Hinxton, Cambridge.

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