Developing the next generation of biomedical talent: a snapshot of UK support for early career researchers

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The Academy *of* Medical Sciences

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This report was prepared as the Academy of Medical Sciences' response to the US National Academy of Sciences commissioned papers on international comparisons as part of the Next Generation Researchers Initiative.

Opinions expressed in this report do not necessarily represent the views of the Academy of Medical Sciences, or its Fellows.

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Introduction

The United Kingdom has a long history of transformative medical research, and continues to punch above its weight in terms of academic success proportional to both funding and population size. The UK is home to world-class higher education institutions (HEIs) and well-resourced research funders, and has created nearly a quarter of the world's top 100 medicines.[1] Together, this ecosystem provides the expertise, resources and culture to translate truly innovative biomedical research into benefits for society. The UK's success owes much to its long-term investment in research, its talented research base and its unique research culture. There is nevertheless acceptance of the need to grow the scale of investment, and to support the careers of our researchers, to ensure that the UK continues to be a world-leader.

This paper was produced at the request of the US National Academy of Sciences to help inform its Next Generation Researchers Initiative. The Academy of Medical Science (the Academy) was contacted in July 2017 to provide a UK perspective alongside a number of papers on international approaches to supporting the next generation of research scientists, and submitted this in September 2017.

The Academy has a long-standing interest in supporting early career researchers and our recent analyses have identified that those making the transition to independence are in greatest need of support. We therefore welcome the National Academy of Sciences' (NAS) focus on this topic. The NAS initiative provides an opportunity for the UK to reflect on its strategy and provision of support for early career researchers, to best share ideas and learn from innovative approaches in the US and other countries. We hope that this paper – which outlines the UK's research system and approach to supporting early career researchers towards independence – will help to inform the strategies the NAS aims to progress in the US. Given the Academy's remit, the focus of this paper is on biomedical and clinical academic research.

1. The Academy of Medical Sciences (2010). *Reaping the rewards: a vision for UK medical science.* https://acmedsci.ac.uk/file-download/35181-51b9ca237ecdf.pdf

1. Funding and structure

The UK has an academic ecosystem that combines public, charity and industry funding for medical research. This means that there are multiple routes of funding and support that researchers can seek depending on their stage of career. The diversity and interdependent nature of this funding base is considered to be a differentiating strength of the UK.

The most recent data comparing the Organisation for Economic Co-operation and Development (OECD) countries (2014) showed the UK government invests around $3 billion into health research and development (R&D), the second highest level of expenditure on health R&D behind the US.[2] In 2014, the UK represented just 0.9% of the global population, 2.7% of R&D expenditure, and 4.1% of researchers, while accounting for 9.9% of downloads, 10.7% of citations and 15.2% of the world's most highly-cited articles. The UK's field-weighted citation impact (an indicator of research quality) is well above the world average and it continues to rank first amongst the comparator countries, despite a slowdown in its rate of growth and a relatively unchanged share of global articles.[3]

2. Office for Life Sciences (2016). *Life Science Competitiveness Indicators.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/523269/BIS-16-236-Office-for-Life-Sciences-OLS-life-science-competitiveness-indicators-report-May-2016.pdf

3. Department for Business, Energy and Industrial Strategy (2016). *Performance of the UK research base: international comparison.* https://www.gov.uk/government/publications/performance-of-the-uk-research-base-international-comparison-2016

As described below, the UK is aiming to be in a position to deliver even greater impact in its research and innovation performance as a consequence of recent organisational changes and evolution of the funding landscape.

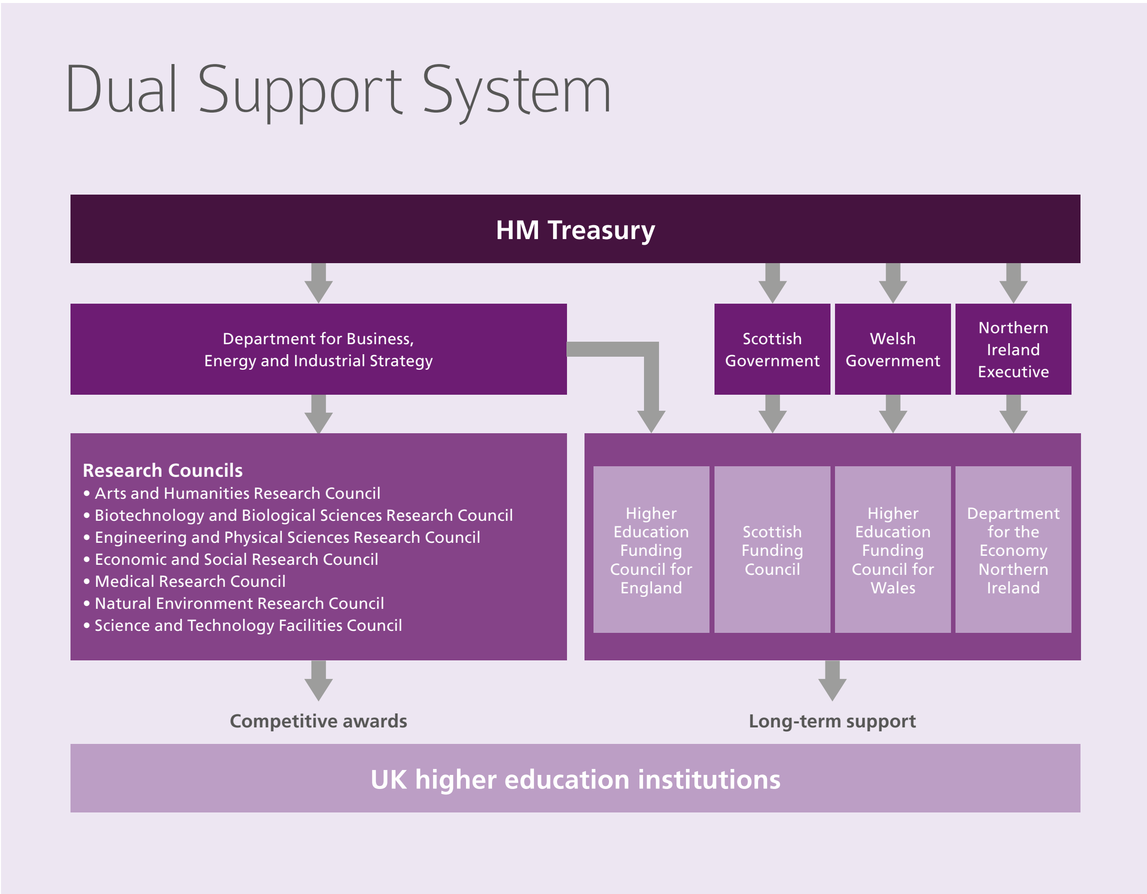
The following sections highlight the core sources of government funding for biomedical and behavioural research: Higher Education Funding Councils, Research Councils, the National Institute for Health Research (NIHR), and the national academies.

1.1 The dual support system

The UK government funds research in HEIs through the **dual support** system (figure 1). This model is unusual in that it provides a balanced mix of **long-term block funding** (through quality-related research allocations from the Higher Education Funding Councils) and short-term, project-based **competitive awards** (through the Research Councils). In addition, a significant proportion of public funding is provided for clinical research through the NIHR. This dual support system is based on the Haldane Principle, which states that spending decisions around research funds should be made by researchers themselves through peer review, independent of political influence.

The Higher Education Funding Councils provide block grants to HEIs for research infrastructure and to support their strategic research priorities. They are allocated through a national exercise conducted every six or so years termed the Research Excellence Framework (REF) (see **section 1.8** for more details). There is a regionally devolved system of funding for higher education: the government's Department for Business, Energy and Industrial Strategy (BEIS) supports the Higher Education Funding Council for England (HEFCE), while the Scottish and Welsh equivalents are supported by the Scottish Government and Welsh Government, respectively. In Northern Ireland, funding comes from the Department for the Economy.

Figure 1: The UK's dual support funding system (pre-April 2018 changes)



1.2 Research Councils

The UK government's science budget is administered through BEIS. The **seven UK-wide Research Councils** (listed in figure 1) receive funding from this budget. The Research Councils are currently represented by an umbrella organisation, Research Councils UK (RCUK), which facilitates joint working between the Research Councils.

The Research Councils champion their specific disciplines, but at the same time attempt to manage interdisciplinary boundaries, and seek to achieve a balance between **responsive mode awards** based on research topics proposed by researchers, and more **targeted, strategic funding in priority areas.** The balance remains in favour of responsive mode funding, although investigators are encouraged to align their applications with strategic priorities. Research Councils also award fellowships to individual investigators to support career development. Out of the seven Research Councils, the Medical Research Council (MRC), the Biotechnology and Biological Sciences Research Council (BBSRC) and, to a lesser extent, the Engineering and Physical Sciences Research Council (EPSRC), fund biological and health-relevant research in the UK, with the MRC being the largest funder.

Within the Research Councils, the MRC is responsible for coordinating and funding medical research in the UK. In 2015/16, the MRC's gross research expenditure was £927.8 million compared to £771.8 million in 2014/15. This support for biomedical research included grants to researchers in HEIs, medical schools and research institutes; programmes within the MRC's own units and institutes; programmes within HEI units and the Francis Crick Institute[4]; and studentships and fellowships in HEIs, medical schools and research institutes.[5] The MRC supports more than 5,700 research staff, 200 postdoctoral fellows and 1,900 PhD students across the full spectrum of health disciplines, many working with industry.[6] During 2015/16, the MRC received 1,720 research grant applications. From these, 349 awards were made, leading to the commitment of £259.1 million for new research. The average success rate for applications for the year is at 22%, which is in line with the nine year average (2006/07 to 2014/15) of 22.4%.[7]

One of three key strategic research priorities for the BBSRC is Bioscience for Health. The BBSRC currently invests around £25 million per annum on research directly aligned to Bioscience for Health, representing approximately 9% of overall research funding.[8] The BBSRC is investing £125 million of funding over five years to support the training and development of 1,250 PhD students; 10% of these will be in Bioscience for Health. The Bioscience for Health portfolio supports 21.6% of researchers across all BBSRC-funded research. This includes 19 New Investigators, 10 fellows, 415 co-investigators, and 244 principal investigators (PIs).

1.3 The National Institute for Health Research (NIHR)

The NIHR, funded by the Department of Health for England, is the largest national clinical research funder in Europe. The NIHR spends £1 billion per year through four main work strands:

- Research (commissioning and funding patient-related research).
- Infrastructure (providing the facilities and people for a thriving research environment).
- Faculty (supporting the individuals carrying out and leading research).
- Systems (promoting faster, easier clinical research through unified, streamlined and simple systems for managing ethical research and its outputs).

4. https://www.crick.ac.uk/
5. https://www.mrc.ac.uk/about/what-we-do/spending-accountability/facts/
6. MRC (2015). *Bringing Research Careers into Focus: An MRC Review of Next Destinations.* https://www.mrc.ac.uk/publications/browse/mrc-review-of-next-destinations/
7. https://www.mrc.ac.uk/research/funded-research/success-rates/
8. Biotechnology and Biological Sciences Research Council (2015). *Bioscience for Health, Strategic Research Framework: 2015–2020.* http://www.bbsrc.ac.uk/documents/bioscience-for-health-booklet/

The NIHR offers a range of training and career development awards comprising both personal awards, which are applied for directly, and institutional awards, which are applied for through the host institution. In 2016, the NIHR managed 2,031 active trainees in awards across their trainees programmes and appointed four new Research Professorships. In addition, it supported a total of 3,678 trainees based in their National Health Service (NHS) infrastructure, of which 2,765 were PhD students.[9]

The NIHR's Biomedical Research Centres are large partnerships between NHS provider organisations and HEIs in England that conduct translational biomedical research.[10] These centres offer a number of PhD studentships and postdoctoral clinical training fellowships that support research in a wide range of areas. The NIHR has also been instrumental in creating a structured career pathway for clinical academics, known as the Integrated Academic Training (IAT) Pathway in England and Wales (discussed further in section 3). A similar integrated training and career development pathway is offered in Scotland operated by Scottish universities in partnership with NHS Education for Scotland.

Strategic coordination of research

Two current UK initiatives for the coordination of research are highlighted below:

The **Office for Strategic Coordination of Health Research (OSCHR)** was created in 2007 under the chairmanship of Professor Sir John Bell FRS HonFREng FMedSci, Regius Professor of Medicine at the University of Oxford and then President of the Academy of Medical Sciences. OSCHR's role is to take an overview of budgetary division and research strategies of both the MRC and NIHR. OSCHR reports to the Secretaries of State for Health and for BEIS, and allows for strategic input from the health departments of the devolved administrations.[11]

The **UK Clinical Research Collaboration (UKCRC)** was established in 2004 with the aim of 're-engineering the clinical research environment in the UK' by bringing together the major stakeholders influencing clinical research in the UK. It was formed as a direct response to the Academy's influential report, 'Strengthening Clinical Research'.[12] Partners include the major UK health research funding bodies, academia (including the Academy), the NHS, regulatory bodies, the bioscience, healthcare and pharmaceutical industries, and patients.[13]

1.4 National academies

The four UK national academies are the Academy of Medical Sciences, the British Academy, the Royal Academy of Engineering, and the Royal Society. Similar to the Research Councils, the national academies receive funding from the science budget administered by BEIS. The proportion of funding received from BEIS to support research talent varies across the academies, and some have a larger funding portfolio than others.

The Royal Society has a large funding portfolio across all areas of the life and physical sciences, including engineering. The national academies tend to offer competitive awards to support ideas and individuals (a number of which target the transition to independence stage) rather than large-scale institutional projects or research programmes. Academies also offer bespoke support through mentoring and career development activities. In the year ending 31 March 2016, the Royal Society spent £53.5 million on grant awards.[14] In 2016, the Academy awarded £4.9 million in total through its targeted research funding schemes to 112 grant awardees.[15]

9. National Institute for Health Research (2016). *NIHR Annual Report 2015/16.* https://www.nihr.ac.uk/about-us/documents/NIHR-Annual-Report-2015-16.pdf
10. https://www.nihr.ac.uk/about-us/how-we-are-managed/our-structure/infrastructure/biomedical-research-centres.htm
11. House of Lords Science and Technology Committee (2009). *Setting priorities for publicly funded research. Memorandum by the Office for Strategic Coordination of Health Research (OSCHR).* https://publications.parliament.uk/pa/ld200910/ldselect/ldsctech/104/10011203.htm
12. The Academy of Medical Sciences (2003). *Strengthening Clinical Research.* https://acmedsci.ac.uk/file-download/34704-pscr.pdf
13. http://www.ukcrc.org/about-the-ukcrc/what-is-the-ukcrc/
14. The Royal Society (2016). *Trustees' report and financial statements.* https://royalsociety.org/~/media/about-us/governance/trustees-report-2015-2016.pdf
15. The Academy of Medical Sciences (2017). *Annual Report and Financial Statements.* https://acmedsci.ac.uk/file-download/13888488

1.5 Non-governmental funding of research

In addition to public sector funders, a large amount of research funding in the UK comes from not-for-profit non-public organisations such as charities and foundations[16], and from industry, as well as from funding streams provided by the European Union (EU).

Charities play an essential role in the UK's rich ecosystem of medical research funders, funding around £1.6 billion of research per annum – 45% of all publicly-funded medical research in the UK (Figure 2). These charities receive strong public support in the UK, with medical research receiving the largest share of donations by monetary value (16%) and support by the largest proportion of donors (33% in 2014).[17] Charity-funded medical research is exempt from value added tax (VAT). The UK is home to many uniquely strong medical research charities, including Arthritis Research UK (ARUK), the British Heart Foundation (BHF), Cancer Research UK (CRUK) and Wellcome. Unlike ARUK, the BHF and CRUK which are funded by public donations, Wellcome's funding depends on the returns of investments on an endowment.

The Association of Medical Research Charities (AMRC) is the national membership organisation of leading health and medical research charities and seeks to harness the strength of its membership (140 medical charities) to influence the policy and research environment. There are many small funders who cannot support large research programmes, but who support pilot studies and 'early' awards to enable researchers to gain additional awards from larger funders.[18] These awards are often particularly valuable to scientists in their transition to independence. Charities also contribute to the knowledge economy by funding the salaries of over 17,000 researchers in the UK.[19]

The value of these non-governmental investments in science is recognised through policies such as the Charity Research Support Fund (c. £198 million in England in 2017/18). This fund is distributed as part of the block grant from the Higher Education Funding Councils to HEIs to cover their indirect costs, allowing charity donors' money to be spent directly on research. Biomedical research funded by charities also leverages further investment from the private and the public sectors.[20]

16. It is important to note that some of the terminologies used to define the players in the research funding landscape vary between the US and the UK. For example, there is no commonly accepted legal definition in Europe for a foundation. In the UK, the word 'foundation' is sometimes used in the title of a charity. In general, private foundations are non-profits, usually funded by an individual or a family, that depend on returns on the investment of their endowment to fund their work, while charities rely on voluntary donations from the public, which the government encourages through a tax-relief system known as Gift Aid.

17. Charities Aid Foundation (2015). *UK giving 2014: An overview of charitable giving in the UK during 2014*. https://www.cafonline.org/docs/default-source/about-us-publications/caf-ukgiving2014

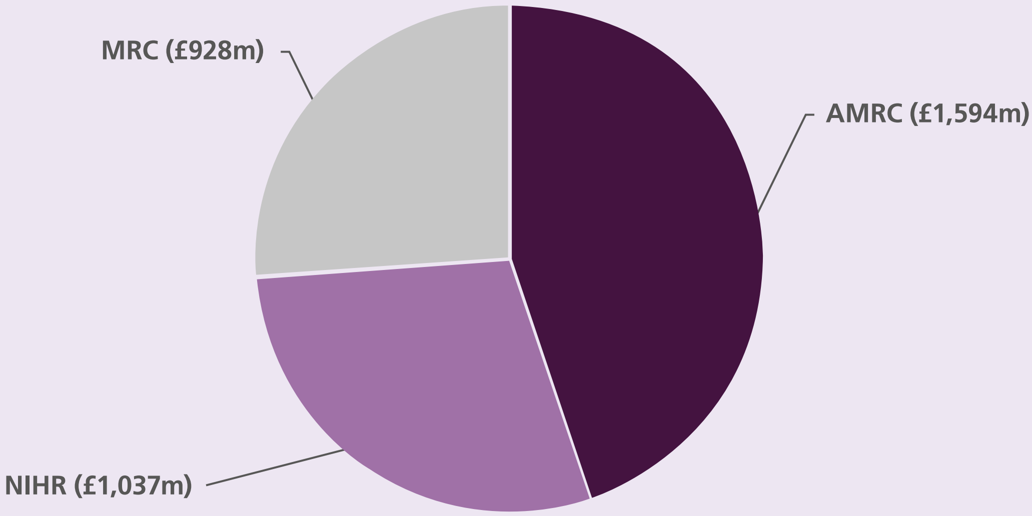
18. https://www.researchmedia.com/amrc/making-a-difference-impact-report-2017/stimulating-further-research-via-new-funding-or-partnerships/

19. https://www.amrc.org.uk/Pages/Category/key-stats

20. Health Economics Research Group Brunel University, Office of Health Economics and RAND Europe (2008). *Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK*. https://www.mrc.ac.uk/publications/browse/medical-research-whats-it-worth/

Figure 2: Medical research charities spent £1.6 billion on medical and health research in the UK in 2016. Research spending by health departments in Scotland, Wales and Northern Ireland is not included.[21]

Public funding for medical research



Note: AMRC members consist of charities that raise money through a range of different routes including public donations, trusts and foundations, legacies, and commercial (charity shops) to name a few.

Wellcome is the UK's largest provider of non-governmental funding for biomedical research. In 2015/16, it received over 5,000 applications requesting £5 billion in funding, and made 1,461 awards worth £822 million. Most Wellcome schemes have an award rate of 20–25%.[22] Wellcome currently supports schemes aimed at transition to independence and independent stages including 411 Investigator Awards, 45 Principal Fellowships, 143 Senior Fellowships, 353 Intermediate Fellowships, as well as 178 Early Career (Postdoctoral) Fellowships, and 955 (Pre-doctoral) Studentships. Wellcome's Institutional Strategic Support Fund (ISSF) enables universities in the UK and Ireland to invest in short-term fellowships and seed funding for early career researchers. **In 2015/16, Wellcome spent 11.8% of its total science spend on transition to independence awards (SEED Awards, Transitioning Fellowships and ISSF).**

1.6 Industry

On the commercial side, in 2015 the **pharmaceutical industry** invested £4.2 billion in R&D in the UK – equating to a fifth of all UK business R&D spending.[23] In recent years, pharmaceutical and biotechnology companies have collaborated more with HEIs and research institutes, with large-scale open innovation centres such as the Francis Crick Institute bringing together scientists from different organisations or groups in physical proximity.[24]

21. https://www.amrc.org.uk/Pages/Category/key-stats
22. https://wellcome.ac.uk/funding/managing-grant/grant-funding-data-2015-2016
23. http://www.abpi.org.uk/media-centre/newsreleases/2017/Pages/High-investment-in-pharmaceutical-RD-underpins-increased-investment-in-collaborative-working.aspx
24. The Academy of Medical Sciences (2016). *The UK drug discovery landscape.* https://acmedsci.ac.uk/file-download/71272985

Recent changes in the UK drug discovery landscape have led to conversations about how to support the next generation of researchers working in industry. Many scientists who currently work in biotechnology companies and contract research organisations (CROs) originally trained in large pharmaceutical companies. As in-house drug discovery in large pharma is downsizing, this pipeline of trained researchers is no longer sustainable. Concerns have been raised about whether biotechnology companies, which are typically small-to-medium-sized, have the time and budget to develop young employees.[25]

1.7 Research investment from outside the UK

Public spending on medical research in the UK also attracts investment from the EU, non-UK charities and other international research funders.[26] For instance, in terms of funding awarded on a competitive basis between 2007–2013 through the EU's main instrument for funding research (Framework Programme 7), the UK was the second largest recipient after Germany, securing €6.9 billion out of a total of €55.4 billion.[27] In 2014/15, UK HEIs received £725 million in research grant income from EU sources. UK biosciences received the second highest amount of research income funding (including grants, projects and infrastructure funding) from EU government bodies at £91 million, while psychology and behavioural sciences received £14 million.[28]

1.8 How funding is distributed

There are three main ways for the distribution of public and non-governmental funding: through the REF, open competition, or other formula-driven allocations. The major benefit of the UK's hypothecated dual funding mechanism is that it has successfully fostered a cluster of elite institutions in the UK and, crucially, supported a disproportionate number of high-performing institutions at all levels.[29]

The REF: Funding Councils run a periodic assessment exercise called the REF to assess the quality of research in HEIs for funding purposes. Institutions are asked to submit examples of their best research to be assessed by subject-specific REF sub-panels (made up of academics and industry experts). In the last REF (2014), the quality of research was assessed using three indicators: outputs, impact of research, and the research environment. This method for calculating research funding enables a degree of research stability and independence not provided by other funding sources.[30]

Open competition: The Research Councils, national academies and research charities have open, competitive calls for research proposals or programmes, which are forward looking and assessed through peer review.

Formula-driven: The majority of awards for clinical academic trainees on the NIHR IAT Pathway are allocated via a funding formula each year, whereas a smaller number are allocated through competition between institutions, again on an annual basis. The formula allocation is at least in part, and non-linearly, driven by the magnitude of awards received through competition. The aim of this mixed model is to ensure that the specialty spread being proposed will deliver a good balance of academic training across England.

25. The Academy of Medical Sciences (2016). *The UK drug discovery landscape.* https://acmedsci.ac.uk/file-download/71272985
26. The Academy of Medical Sciences (2010). *Biomedical research - a platform for increasing health and wealth in the UK*. https://acmedsci.ac.uk/file-download/35206-Biomedic.pdf
27. https://royalsociety.org/topics-policy/projects/uk-research-and-european-union/role-of-EU-in-funding-UK-research/how-much-funding-does-uk-get-in-comparison-with-other-countries/
28. Technopolis (2017). *The role of EU funding in UK research and innovation.* https://acmedsci.ac.uk/file-download/70343877
29. The Academy of Medical Sciences (2016). *The Academy of Medical Sciences' evidence to the Public Bills Committee examining the Higher Education and Research Bill.* https://acmedsci.ac.uk/file-download/41568-57cea8bc15326.pdf
30. http://www.hefce.ac.uk/rsrch/funding/

1.9 Differences between the UK and US funding systems

A key difference between the US and the UK systems is the UK's broad range of basic research funders and its particular emphasis on charitable funding. Researchers can apply to multiple funding sources at the same time, but usually need to disclose all applications and any resulting awards to the funding body. It may be helpful to note here that fellowships in the UK refer to the first independent PI role for a researcher, unlike in the US where fellowships from charities and other sources may be used by postdoctoral researchers to fund their salary while working in a PI's lab. The UK Research Councils tend to cover a smaller proportion of the innovation chain than the more mission-led funders in the US.[31]

Similar to the US, the kind of biomedical research supported by medical research charities in the UK tends to be different from that funded by government bodies, focusing more on research into understanding the cause and development of disease, rather than generic health relevance and basic underpinning biology. In addition, charitable funding clusters around discovery/laboratory research whereas government funding is more evenly distributed across all research activities.[32]

1.10 Recent changes in the research funding landscape

The research funding landscape in the UK is in a period of transition. Imminent reforms to internal funding structures, new funding streams, and external factors such as the UK's vote to leave the EU all have a sector-wide impact. Chief among the domestic changes is that all seven Research Councils will from 2018/19 be included under a single umbrella agency – **UK Research and Innovation (UKRI).** This will provide a unified voice for the UK's research and innovation system and encourage more interdisciplinary science.[33] In addition, an eighth council within UKRI, Research England, will be created to sustain the conditions for a healthy and dynamic research and knowledge exchange system in English HEIs.

Additional funding is being provided through a new five-year £1.5 billion Global Challenges Research Fund which forms part of the UK government's Official Development Assistance (ODA) commitment, and focuses on promoting the economic development and social welfare of developing countries. The UK government's Industrial Strategy is expected to provide additional investment into the life sciences as part of £4.7 billion of additional R&D funding over the next four years. A recent independent review of the life sciences, which fed into the strategy, has recommended an additional £146 million of funding for the sector.[34] In addition, £160 million from the new National Productivity Investment Fund will predominantly fund fellowships including those aimed at transition to independence.[35] A new £100 million Ernest Rutherford Fund will also provide fellowships for early career and senior researchers from the developed world and from 'emerging research powerhouses' such as India, China, Brazil and Mexico.[36]

The UK's decision to leave the EU could impact on both the funding the UK attracts for research and its ability to attract research talent. Sixteen per cent of UK academic staff are non-UK EU citizens.[37] Following the referendum result, EU nationals working in the UK have reported concerns about how changes to the freedom of movement might affect their future right to work in the UK. There have also been anecdotal reports of UK scientists becoming marginalised in EU research collaborations following the vote.[38,39] At the time of writing, it was not clear what the full impact of leaving the EU could have on the UK biomedical research community. However, the development of a fair and transparent immigration policy will be a priority for ensuring that the UK can continue to attract and retain talented researchers from abroad.

31. https://www.ukri.org/research/international/ukri-international-offices/ukri-usa/research-landscape-in-the-usa/
32. https://hrcsonline.net/reports/analysis-reports/uk-health-research-analysis-2014/
33. http://www.legislation.gov.uk/ukpga/2017/29/contents/enacted/data.htm
34. https://www.gov.uk/government/news/sir-john-bell-to-unveil-industry-led-proposals-to-build-uks-status-as-world-leader-in-life-sciences
35. Morgan J (2017). *Budget 2017: £250 million allocated to PhD places and fellowships.* Times Higher Education (THE), March 8. https://www.timeshighereducation.com/news/budget-2017-ps250-million-allocated-phd-places-and-fellowships
36. https://www.gov.uk/government/news/100-million-rutherford-fund-to-attract-best-researchers-to-the-uk
37. https://royalsociety.org/topics-policy/projects/uk-research-and-european-union/role-of-eu-researcher-collaboration-and-mobility/snapshot-of-the-UK-research-workforce/
38. Ghosh P (2016). *UK scientists speak about Brexit pain.* BBC News, July 19. http://www.bbc.co.uk/news/science-environment-36835566
39. https://sruk.org.uk/initiatives/science-policy/brexit/

In terms of the cultural landscape, work is being done by the Royal Society to explore the future of research culture in the UK. The project is examining questions such as: What will UK research culture look like in 2035? How will researchers communicate their work, be assessed and what will career structures look like? How do we ensure this future research culture continues to support the research excellence for which the UK is renowned?[40] Following a special issue of the scientific journal Nature in October 2016, which explored the pressures facing early and mid-career researchers, work is being led by Sir Philip Campbell, Nature's editor-in-chief, to identify factors that could indicate the 'health' of the research group. This would include quality of communication, training, integrity, research culture, and support.

40. Downey F (2016). *The future of Research Culture in the UK*. The Royal Society, December 13. http://blogs.royalsociety.org/in-verba/2016/12/13/the-future-of-research-culture-in-the-uk/

2. Peer review

2.1 Principles and processes

Research funders in the UK make funding decisions on grant applications on a competitive basis using independent, expert peer review. More than 95% of the £2 billion of public funding for medical research each year in the UK is allocated by peer review (figure from 2012).[41] Funders seek external expert opinion when undertaking peer review. This is most commonly done through a combination of written review and a committee of external experts. There may also be additional steps such as internal triage, where the funder checks the eligibility of research applications. Anecdotally, some people have identified that a key difference between the approaches taken in the UK and in the US may be that research grant applications in the US are generally more lengthy, compared to the relatively shorter UK grant applications which are considered to be succinct.

The Research Councils and the NIHR use the expertise of a number of senior academics from the UK and overseas to assess proposals for research funding based on scientific quality and robustness. The NIHR Reviewer Development Scheme offers NIHR Research and Infrastructure trainees the opportunity to gain experience of expert review for their funding programmes and influence research commissioning.[42]

41. https://www.rand.org/content/dam/rand/pubs/research_briefs/2012/RAND_RB9682.pdf
42. https://www.nihr.ac.uk/funding-and-support/funding-for-research-studies/become-a-reviewer/register-for-the-reviewer-development-scheme.htm

The Research Councils UK Peer Review Framework outlines what information is routinely published relating to proposals and awards, and the approach taken by the Councils in responding to requests for information about the assessment process.[43] The process used by the Research Councils seeks to judge the potential of research before it is conducted rather than just review research outcomes. Similarly, the national academies use the expertise of their elected fellowships in addition to external reviewers to assess research proposals.

A report by the AMRC, the national membership organisation of health and medical research charities, notes that 'peer review looks very different across our membership and varies depending on the type of research being undertaken, who is doing it and for how long'. For example, charities offering small pilot grants with a value of less than £50,000 sometimes choose a streamlined version of peer review whereby applications are assessed by a research review committee and do not necessarily seek written review. Other charities that fund large rolling programme grants need a more thorough review but at longer intervals (typically every five years). These can be supplemented with up to five written reviews, a site visit, and an interview with the director and senior staff.

Peer review is an AMRC membership requirement, and every five years the AMRC audits members' peer review processes to ensure they are operating according to the principles of peer review advocated by the AMRC:

- **Balance:** ensuring that the research review committee reflects a fair balance of experience and research disciplines. This could include patients, careers, or industry representatives.
- **Accountability:** ensuring charities are open and transparent about their peer review procedures and publish details online.
- **Independence:** ensuring the research review committee is independent of the charity's administrative staff and trustees.
- **Rotation:** ensuring members of the research review committee have a fixed term of office.
- **Impartiality:** ensuring charities have a clear conflict of interest policy for their peer review process.[44]

There has been a recent push from UK research funders to ensure that their grant review processes are fair and do not adversely affect certain groups. Since 2015, RCUK has rolled out face-to-face or online unconscious bias training for peer reviewers and those involved in giving strategic advice to RCUK and making decisions on RCUK funding.[45]

2.2 Alternatives to peer review

In large part driven by the demands on academics, research funders are increasingly experimenting with new ways to assess research proposals for a wide range of awards. A report by RAND Europe highlights a range of approaches that offer alternatives to, or modifications of, traditional peer review.[46] The Academy is not aware of any assessments done to evaluate how these approaches compare to traditional peer review. The RAND report notes that their evaluations of these approaches are based on evidence from existing literature, which tends to be biased towards highlighting the merits of a particular approach, rather than balancing it against any shortcomings. A few UK-based examples from the RAND report include the following:

- **Sandpits:** A sandpit is a residential interactive workshop held over five days involving 20-30 participants, a director and a team of expert mentors. Sandpits can include people at different stages in their career, not just those in senior academic posts. Participants stay for the whole duration of the event, during which teams are formed to bid for project funding that is usually awarded at the end of the workshop through a rapid and iterative review process. This process fosters transparent peer review and encourages substantive changes to improve the proposed research. The IDEAS Factory initiative of the EPSRC funded a number of sandpit reviews on topics in need of a fresh approach – such as nutrition for older people, mobile healthcare delivery and coping with extreme weather events. There has been some criticism of sandpits as the residential nature of these events can preclude female participation, due to factors such as caring commitments.[47]

43. https://www.ukri.org/funding/peer-review/
44. AMRC (2015). *Raising the standards of research funding: an audit of how AMRC members undertake peer review.* https://www.amrc.org.uk/peer-review-audit
45. RCUK (2016). Action Plan for Equality, Diversity and Inclusion. https://www.ukri.org/files/legacy/skills/action-plan-edi-2016/
46. RAND Europe (2013). Alternatives to Peer Review in Research Project Funding. https://www.rand.org/pubs/research_reports/RR139.html
47. Robertson J (2013). *Are research sandpits a good way to allocate public funding to research?* The Guardian, December 18. https://www.theguardian.com/higher-education-network/blog/2013/dec/18/research-council-sandpits-funding-decisions

- **Feedback from a review panel or conditional funding to strengthen promising applications:** An example of this is the UK's Motor Neurone Disease Association who can depart from traditional peer review processes when allocating healthcare research grants. Following the submission of one or more potential applications, the Research Advisory Panel works with the researchers to improve specific points through feedback and discussion before the application is sent for external peer review. Similar feedback-driven improvement, which is aimed at increasing efficiency and reducing wasted applicant time, is becoming increasingly common in the UK and, to some extent, is employed by Wellcome and CRUK.

- **Portfolio approach to support high-risk projects:** Wellcome's Showcase Awards were designed to fund high-risk research that was unlikely to be selected via the traditional peer review process. Between 1996 and the early 2000s, about 20 such awards (of about £40,000 over 12 months) were given each year. An evaluation at the end of the first year of the awards involved an experiment to assess how innovative the Showcase Awards were perceived to be, in comparison with a sample of standard project grants. The results show that Showcase was fulfilling its objective of supporting high-risk research and that it is possible to apply novel techniques to evaluate unusual schemes.[48] CRUK's Pioneer Award funds small-scale, high-risk and high-reward research that, due to its novelty or lack of supporting data, would be unlikely to secure funding through traditional funding mechanisms. To encourage innovation in research, the awards committee adopt the following practices:
    - A quick and flexible application process.
    - No written peer review at the application stage.
    - A concise application template.
    - Preservation of applicant anonymity until the interview stage of the selection process.[49]

- **Long-term programme grants:** The BHF offers long-term programme grants on a five-year rolling basis. Renewal applications are reviewed by an external peer review panel and an internal programme grants committee, and revision of the research proposal is typically required. The renewal process begins 18 months before the end date of the current award. Similarly, Wellcome Senior Research Fellowships can, at present, be renewed competitively for several rounds. While this strategy helps researchers overcome the barrier to the renewal of existing projects and supports long-term programmes that can demonstrate success within five-year intervals, it can become progressively difficult to stop funding. Also, increased funding for renewals implies less funding for creative new approaches. The optimal balance of new versus renewal funding to drive innovation is unclear.

- **The inclusion of lay reviewers:** Asthma UK's scoring system for the allocation of research funding[50] has helped to ensure effective inclusion of the views of lay reviewers (non-scientists who are affected by asthma). They have been involved in the review panel since 2009. Incorporating the views of lay reviewers and patient groups increases the likelihood of research being conducted that is tailored to societal needs.[51] Patient and public involvement is a prerequisite for many health research funders such as the James Lind Alliance.[52]

48. Grant J & Allen L (1999). *Evaluating high risk research: An assessment of the Wellcome Trust's Sir Henry Wellcome Commemorative Awards for Innovative Research.* Research Evaluation **8**(3), 201–204.
49. http://www.cancerresearchuk.org/funding-for-researchers/applying-for-funding/funding-committees/pioneer-awards-committee#pionnerrawards1
50. https://www.asthma.org.uk/globalassets/research/for-researchers/non-clinical-fellows/2017-senior-fellowships---faqs-on-lay-involvement.pdf
51. RAND Corporation (2013). *Alternatives to Peer Review in Research Project Funding.* https://www.rand.org/pubs/research_reports/RR139.html
52. http://www.jla.nihr.ac.uk/about-the-james-lind-alliance/

3. Early career investigators

Research funders in the UK recognise the need to support and nurture early career researchers to maintain and grow the UK's talented research base. The transition to independence is seen as a key pinch point in the research career pathway. Support for these roles comes from a range of sources; these multiple research funders are outlined in **section 1.**

UK research funders take a more traditional view of the concept of 'independence' in relation to research careers. One of the key features that UK funders look for in applicants wishing to apply for grants or fellowships that support transition to independence is their potential to branch out from their current research group and create their intellectual niche as a 'group leader'. A researcher wishing to develop their own project under a PI will not generally be considered to be competitive for these schemes. Funders we spoke to acknowledged that this set-up can disadvantage highly talented people (such as staff scientists) who may be working with a biomedical PI within a team but who are intellectually independent.

The table below provides a guide to the job titles in academia in the UK and their involvement with research. It applies to most UK HEIs although some may have their own definitions. There has been a shift towards US style titles in some UK HEIs to make job adverts more globally understandable, for example with the use of the assistant and associate professor titles.[53]

53. Gibney E (2013). *Oxford consults on 'associate professor' grade.* Times Higher Education (THE), February 14. https://www.timeshighereducation.com/news/oxford-consults-on-associate-professor-grade/2001542.article

Table 1: Job titles in UK higher education

Title	Description
Research associate	Postdoctoral staff working on a project funded by a grant won by a PI.
Teaching fellow	Staff who carry out teaching and administrative duties with no research component to their contract.
Lecturer/assistant professor*	Staff who have research, teaching and service components to their contracts.
Senior lecturer/reader/ associate professor*	A position gained by promotion, based on a higher and more sustained contribution to research, teaching and service than a lecturer/assistant professor. The title of reader is somewhat anachronistic; it used to relate to a long service award for research excellence, but is now incorporated as a separate promotion in many HEIs.
Research fellow	Staff employed to undertake full-time independent research with a lower teaching component to their contract. Fellowship awards are distinct from funding used to support postdoctoral staff (even named) on research grants.
(Full) professor*	The most senior academic staff within an HEI or research institute. A position gained by promotion, based on a higher and more sustained contribution to research, teaching and service than a senior lecturer/reader/associate professor. A number of professors in UK universities are funded by MRC or Wellcome senior or principal fellowships. An endowed professorship (or endowed chair) is a position permanently paid for with the revenue from an endowment fund specifically set up for that purpose.

* US equivalent role

3.1 Multiple routes to independence

There are two parallel academic career tracks for researchers in the UK (more data on specific schemes is given in **online annex A**):

- **Fellowship track** (employed by the HEI, but salary is funded by different funding agencies).
  For basic scientists, there is a range of fellowships from those supporting the transition to independence, through career development fellowships, to senior and principal fellowships. For clinical scientists there is a similar range, including clinician scientist and senior fellowships. Some fellowships mandate that at the end the HEI takes on an increasing part of the salary bill and provides the researchers with a long-term post.
- **Lecturer through to professor track** (usually employed and with a salary funded by the HEI). This is the predominant route as fellowship numbers are limited.

Clinical lecturers spend 50% of their time on research with the hope that this will lead to a nationally funded senior fellowship or an HEI funded senior lectureship which would usually be co-funded with the NHS to support the clinical component of the job. After the completion of training and the award of a certificate of completion of training, the final steps on this academic path are clinical senior lecturer and clinical professor posts. The proportion of time spent in clinical and academic work varies considerably by post.

It is rare for biomedical researchers to move directly from postdoctoral researcher to a lectureship position. Most postdoctoral researchers get into the HEI employed track by first acquiring an externally funded career development fellowship.

Recognising that there are different routes available to enable scientists to transition to independence, the MRC has created an interactive career framework – an online tool that gives information on possible options for careers and funding in biomedical research within academia and/or industry.[54] The framework was created following informal consultation with a broad range of groups including the Academy, charities, industry, other Research Councils and the research community.

The balance of research and teaching

The Academy has long advocated for a research-led teaching approach in universities.[55] Individual UK HEIs are autonomous in managing their teaching/research balance. It is now common for the level of teaching allocations to be the inverse of research performance, such that the contribution of individual academics to the institution is balanced as much as possible. There is intense debate about the merits and consequences of this management process, given the focused nature of research funding and the numbers of school leavers who now go on to study at HEIs (currently 50%). In many HEIs, the introduction and development of teaching-only appointments is a further trend that has emerged in recent years, often as a response to pedagogic changes, the efficiency of delivering only one aspect of an academic role, and the greatly increased student numbers in both medical and bioscience courses.[56] Lectureships encompass both research and teaching responsibilities whereas fellowship holders are expected to focus on research.

Although there are examples of good practice in HEIs' management of fellows, including transparent schemes for the transition of fellows onto HEI-funded posts, there is inconsistency of support provided by host institutions for fellows. Many institutions have failed to clarify their policies on the regulation of teaching and administrative loads and the management of career development for this group of researchers. As highlighted in the Academy's 2005 report, 'The freedom to succeed', issues around the mentoring, appraisal, promotion, training and status of fellowship holders exist in many HEIs. Lack of clarity on this issue also contributes to unsatisfactory arrangements in practical matters such as the provision of space, access to HEI funds and studentships, and expectations of teaching commitments and administration.[57]

A follow-up report to 'The freedom to succeed' observed that much has changed since the 2005 report, however, there are still HEI weaknesses. These weaknesses can be tackled by sharing good practice to maintain the momentum for building research capacity and to embed key improvements in researcher mentoring, retention, diversity and mobility between sectors while collecting evidence on what works.[58]

There is a lack of high-quality data on the number of researchers at the various career levels in academia in the UK. However, some research funders have reported to the Academy that biomedical scientists tend to take longer to consolidate their skills before transitioning to independence, partly due to increased competition and a scarcity of posts.

54. https://www.mrc.ac.uk/skills-careers/interactive-career-framework/

55. The Academy of Medical Sciences (2010). *Redressing the balance: the status and valuation of teaching in academic careers in the biomedical sciences.* https://acmedsci.ac.uk/file-download/35943-53b159424f36e.pdf

56. *Ibid.*

57. The Academy of Medical Sciences (2005). *The freedom to succeed: A Review of Non-Clinical Research Fellowships in the Biomedical Sciences.* https://acmedsci.ac.uk/file-download/34623-AcdMedSc.pdf

58. The Academy of Medical Sciences (2007). *The freedom to succeed: the careers and futures of biomedical scientists in UK academia.* https://acmedsci.ac.uk/file-download/34898-Thefreed.pdf

3.2 Guiding biomedical researchers towards independence

Engagement with early and mid-career researchers across the spectrum of medical science by funders and other stakeholders in the UK has identified a lack of support for early career stages at transition points. In 2014, the Academy and Wellcome both explored the career stage(s) of UK biomedical researchers at which research support is most needed and where the lack of such support is limiting progression. The conclusion was that the **early lecturer career stage, or equivalent, represents a vulnerable group in greatest need of support.** Working with Higher Education Statistics Agency (HESA) statisticians, the Academy estimated that there are upwards of 7,000 biomedical researchers at this stage in UK HEIs. Changes in the funding landscape, particularly the reduction in three-year project grants, have made securing a first or second independent grant increasingly challenging. Three main types of individual were repeatedly identified as requiring support:

- Senior postdoctoral researchers aiming for independence.
- Lecturers, or equivalent, within the first three years of their post who have not yet obtained significant funding.
- Lecturers, or equivalent, attempting to build on their first grant and be competitive for renewed funding or to secure a substantive longer-term award.

The second group was identified as being in greatest need of support. In response, the Academy formulated the **Springboard** scheme to address the funding gap.[59] The scheme supports early career (non-clinical) biomedical scientists at the start of their first independent post. **Online annex A** contains a tabulated summary of research grant schemes available to biomedical researchers transitioning to independence in the UK, information on what they provide, and an indication of demand. Currently, there are few grant schemes in the UK that are open to this career stage across the biomedical sciences; those that do exist cannot meet demand. In this context, the Academy-Wellcome and now BHF partnership to support Springboard is a clear demonstration of a funder tackling a defined area of need by mobilising other funders to work collaboratively and to catalyse consortium-funding models that encourage join-up and leverage significant additional resource. Although there are examples of coordination amongst biomedical research funders to ensure that appropriate investment is made at each career step, there is scope for better coordinated working to enable optimal flow through the workforce pipeline.

3.3 Support for clinical academics transitioning to independence

Until 10 years ago, there was no structure for clinical academic training in the UK. Academic doctors tended to have individual, often idiosyncratic training pathways that balanced research and clinical practice. The increasing regulation of clinical training in the UK made these individual routes less tenable. The NIHR has been instrumental in creating a structured career pathway for clinical academics. Other funders came together to ensure there was a robust pipeline of funding opportunities for clinical academics.

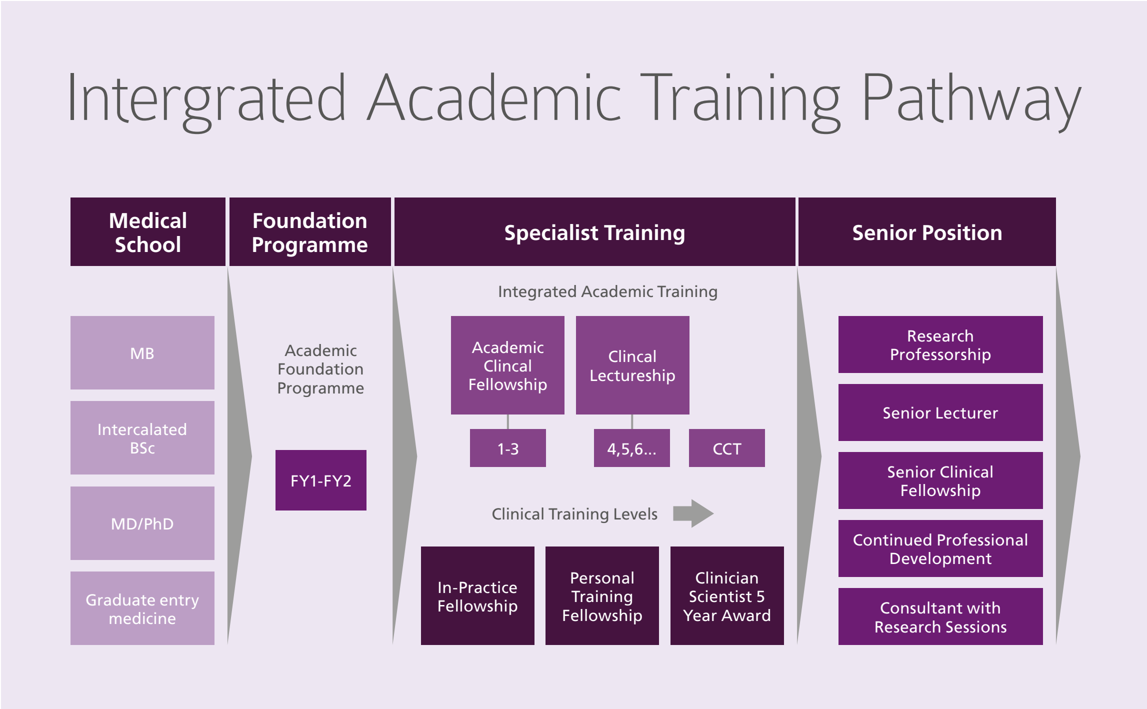
The NIHR IAT Pathway for Doctors is shown below (figure 3).[60] Clinical academics on the IAT Pathway undertake ongoing clinical specialty training, but have 25% of their time protected to undertake academic training and research projects. Trainees at the Academic Clinical Fellow (ACF) level undertake a period of specialty training with protected research time to acquire preliminary data to make themselves competitive for externally-funded fellowships to complete a PhD. On completion of a PhD, the trainee then progresses to the Clinical Lecturer (CL) phase, with the percentage of protected research time increased to 50% to develop and gain independence in their research while completing specialty training. The IAT has funded almost 2,500 ACFs and CLs in the 10 years since its inception.[61] The NIHR's recently released internal review of the training they deliver sets out their 15–20 year vision for academic training in the NIHR.

59. https://acmedsci.ac.uk/grants-and-schemes/grant-schemes/springboard

60. NIHR (2017). *Guide to National Institute for Health Research Integrated Academy Training.* https://www.nihr.ac.uk/funding-and-support/documents/IAT/TCC-NIHR-IAT-GUIDE.pdf

61. Day C (2016). *The changing funding environment for clinical academics.* The Lancet **387,** 3-5. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(16)00262-2/fulltext

Figure 3: IAT Pathway. Unlike in medical education in the US, entry into medical degrees in the UK is not only at graduate level.



The Academy has provided guidance on how funders might best support and build capacity across the clinical academic specialties when allocating both training and senior fellowships, and programmatic funding.[62] UK research funders allow for parallel clinical training through a number of new or revamped schemes for clinical academics. This aims to address the issues in transitioning from doctoral training to independence with postdoctoral fellowships and allow flexibility in these postdoctoral fellowships. Some of these innovative schemes are highlighted in **online annex A**. UK-wide surveys of health research fellowships show that the more senior posts are predominantly funded by the NHS and Funding Councils, whilst the more junior level posts (doctoral researchers) are predominantly funded by other funders such as Research Councils, charities, and industry.[63]

3.4 How institutions support researcher development

Over the last 15 years, there have been various initiatives aimed at improving the support for early career researchers at academic institutions across all science and engineering disciplines. Following a review of science and engineering skills,[64] the UK government allocated c.£150 million to the RCUK in 2003 to increase stipends and the length of PhD programmes, create 1,000 academic fellowship positions, and deliver additional training for RCUK-funded researchers. It included approximately £20 million specifically allocated per year for 'career development and transferable skills training', a sum known as **Roberts Funding.**[65] Between 2003 and 2011, this funding was distributed as a ring-fenced payment to the UK HEIs by the Research Councils on an annual basis. Roberts Funding has ensured that training and development opportunities are now firmly embedded within institutions' structures and practices.[66]

62. The Academy of Medical Sciences (2009). *Building clinical academic capacity and the allocation of resources across academic specialties.* https://acmedsci.ac.uk/file-download/34664-Specialt.pdf

63. https://www.mrc.ac.uk/publications/browse/oschr-uk-wide-survey-of-health-research-fellowships-2009/

64. HM Treasury (2002). *SET for success: The supply of people with science, technology, engineering and mathematics skills.* http://webarchive.nationalarchives.gov.uk/+/http:/www.hm-treasury.gov.uk/d/robertsreview_introch1.pdf

65. 1994 Group (2009). *Survey on the Impact of the Roberts' Fund at 1994 Group institutions.* https://www2.le.ac.uk/departments/gradschool/about/external/publications/roberts-impact.pdf

66. *Ibid.*

A key part in taking forward the UK government's drive to support research careers was the creation of **Vitae,** a UK-wide organisation supporting the professional development of researchers.[67] Vitae leads on the management and implementation of the **Concordat to Support the Career Development of Researchers,** an agreement between UK research funders and employers to improve the employment and support for researchers and research careers.[68] Some institutions, such as the University of Cambridge, have developed more recent plans for the implementation of the Concordat.[69] RCUK's **Statement of Expectations for Research Fellowships and Future Research Leaders** calls for a clear commitment from research organisations to support, develop and mentor research fellows.[70]

Many HEIs have a new academics programme where researchers are inducted over a year, and given support that includes general advice on an academic career, training on local issues such as HEI budgets and human resources practices, guidance on how to teach, and training on more research-related skills such as grant writing. Successful completion of the programme is often a prerequisite for academics passing probation (i.e. moving from a fixed contract to an open-ended contract). However, the provision of such training is variable across HEIs and research institutes.

3.5 Factors impacting on researcher independence

Location of early career researchers and implications

Virtually all PhD students and postdoctoral researchers who are pre-independence tend to be based in research groups led by senior scientists and supported by research grants or programmes. Most biology research groups in the UK are of modest size, containing less than 10 staff and students, including the PI.[71] This reflects the complexity of biological and biomedical research, where it is possible for one PI to focus alone on a single problem, usually with one or two collaborators. However, in the 'omic' era, there is a noticeable trend to greater team working and recognition that if researchers can embrace a broader team science approach and wider collaborations there is the potential for accelerated discovery. The Academy's team science report found that academia is rooted in a tradition of individual and small team scholarship where the emphasis is on leadership and independence: academic reward and recognition systems have failed to match the growth of team working.[72] This not only holds back progress but also produces career challenges for postdoctoral researchers working in teams, particularly through the likely lack of recognition for individuals' contributions, a prominent concern for researchers.

Researchers transitioning to independence are expected to manage their own programmes, teams and/or resources. Lecturers (with the exception of CLs) and above are seen to be independent. Within the spectrum of fellowships, it is recognised that some researchers immediately establish independence whilst other fellows will move into independence during the four or five year fellowship. Fellowships such as Wellcome's Sir Henry Dale Fellowships and the BBSRC's David Phillips Fellowship are independent positions with additional support such as access to mentoring programmes.

The creation of large equipment core facilities is the norm in HEIs, and access to these shared facilities is actively encouraged by HEIs and research institutes as they help foster a collaborative research environment. This is especially useful for researchers establishing their own laboratories as it means that individual researchers do not need to generate funding for equipment and then learn how to use it. When assessing fellowship applications, funders will look at the 3Ps: project, person, and place. The latter signifies whether the environment in which the proposed research will be undertaken is suitable, not only to deliver the project but also for the development of the applicant.

67. RCUK (2010). *Review of progress in implementing the recommendations of Sir Gareth Roberts, regarding employability and career development of PhD students and research staff.* https://research.aston.ac.uk/portal/files/1008566/RobertReport2011.pdf
68. https://www.vitae.ac.uk/policy/vitae-concordat-vitae-2011.pdf
69. https://www.pdoc.cam.ac.uk/dpccn/ConcordatHRexcellence
70. https://www.ukri.org/files/legacy/skills/fellowshipstatement-pdf/
71. Cook I, Grange S & Eyre-Walker A (2015). *Research groups: How big should they be?* Peer J **3**(989). https://peerj.com/articles/989.pdf
72. The Academy of Medical Sciences (2016). *Improving recognition of team science contributions in biomedical research careers.* https://acmedsci.ac.uk/file-download/38721-56defebabba91.pdf

Mentoring and the need for training

Mentoring programmes are widely considered to be beneficial for researchers throughout their training careers, particularly for those at stages of transition, such as the step to academic independence. Mentoring support can provide independent guidance, help reduce isolation and provide role models. An example of mentorship support available to biomedical researchers in the UK is the Academy's highly regarded one-to-one mentoring scheme (box 1).[73]

Box 1. The Academy of Medical Sciences one-to-one mentoring scheme

This scheme provides postdoctoral biomedical researchers with career development support by pairing them with an Academy fellow or senior academic. The Academy promotes a developmental model of mentoring rather than patronage, where the emphasis is on mentees being supported to find their own solutions to the challenges of career advancement rather than the provision of directional advice or patronage. The benefit of a UK-wide programme allows trainees to select a mentor outside of their institution and/or area of expertise. This enables them to draw on more diverse perspectives, seek independent advice, and speak more freely. Training is delivered to both mentors and mentees in one session, which allows a shared understanding of mentoring that is valued by participants. The Academy has catalysed a number of mentoring schemes within the UK and worldwide and is currently working to support the development of more schemes in Africa.

Appropriate support and training is critical for researchers transitioning to independence. The team science report highlighted that despite a growth in team science, individuals (at all levels) often lack the skills required to contribute effectively to collaborative team work.[74] Indeed, a survey of the participants of the Academy's SUSTAIN scheme (a project addressing the challenges women face in the early stages of an independent research career) found that training in leadership and people management skills was highly desired. Survey respondents identified a number of specific research-related topics such as developing and managing a research team as priorities for training.[75]

73. https://acmedsci.ac.uk/grants-and-schemes/mentoring-and-other-schemes/mentoring-scheme

74. The Academy of Medical Sciences (2016). *Improving recognition of team science contributions in biomedical research careers.* https://acmedsci.ac.uk/file-download/38721-56defebabba91.pdf

75. https://acmedsci.ac.uk/grants-and-schemes/mentoring-and-other-schemes/sustain

4. Trainees and the workforce

Ensuring a balanced workforce is a challenge shared by all biomedical research funders, with the need to encourage a sufficient number of trainees into a biomedical research career path that in turn offers enough opportunities for a range of career progression. Anticipating future workforce demand is also important. Funders in the UK have attempted to tackle a number of the challenges faced in achieving the right balance, and to understand where barriers to progression sit in the careers pathway.

4.1 The role of graduate students and postdoctoral researchers in research labs

PhD students and postdoctoral researchers generate most of the data produced in biomedical labs. They are therefore vital to research productivity, but are often underappreciated. Both PhD and postdoctoral groups bring new ideas and enthusiasm as productive members of the UK's research landscape. Postdoctoral researchers have highly specialised knowledge and experience, and produce relevant publications in peer-reviewed academic journals and conferences.

Research laboratories rely on postdoctoral researchers to drive research projects and supervise PhD students on a day-to-day basis. As might be expected given their greater experience, one study of the life sciences research sector in the UK notes that postdoctoral researchers are on average more productive than PhD students or other researchers, with each postdoctoral researcher generating 3.48 papers per five years, compared with PhD students and other researchers who generate 1.53 and 1.98 papers, respectively.[76] Despite this difference, PhD students are essential for research productivity and the training provides an entry point to the career pipeline. Anecdotally, analyses of submissions to the UK's REF indicate a significant contribution of PhD students as co-authors to research outputs that were selected for submission.

4.2 Understanding the barriers to career progression

Barriers to progression for non-clinical researchers

In 2015, the MRC undertook a review to explore the career choices of non-clinical medical researchers in the first 10 to 20 years following their MRC-funded award, and to understand better the nature of any blockers or hurdles that prevent research career progression. The table below highlights the findings of the review in relation to the main blockers and enablers.[77]

Table 2: Blockers and enablers to pursuing a research career

Blockers	Enablers
• Difficulties securing funding. • A lack of careers advice, support and guidance and difficulties accessing what is available. • A lack of job security and availability. • Difficulties balancing work and family life. • A lack of proactivity.	• Funding as a platform for pursuing one's own interests and as a springboard to a career. • Access to careers advice, support and guidance. • Gaining skills and experience through training and research. • Experience outside academia. • The opportunity to publish work. • Mobility.

Securing funding was identified as the biggest blocker, with half of all who remained within research for their first three career transitions reporting they found it difficult to pursue the career they wanted. The most frequently cited transition points that could have benefitted from further advice included: the transition from PhD to postdoctoral researcher, and the transition from postdoctoral researcher to research independence or PI.

Many of the survey respondents identified the **lack of flexibility** in research career choices. For example, researchers have only a certain number of years after their PhD in which to apply for fellowships, after which they are ineligible. Such time-limited cut-offs disadvantage individuals who have taken a career break, those changing career path or wanting to develop new skills as part of a multidisciplinary portfolio, part-time workers, and those with caring responsibilities who may need longer to demonstrate their track record. In response, the MRC led the way in removing completely the eligibility criteria based on years of postdoctoral experience.[78] Wellcome and the EPSRC also have no time-bound criteria for their schemes. The BBSRC has removed it for some of their schemes as has the Royal Society along with Wellcome for their Sir Henry Dale Fellowships.

76. Cook I, Grange S & Eyre-Walker A (2015). *Research groups: How big should they be?* Peer J **3**(989). https://peerj.com/articles/989.pdf

77. MRC (2015). *Bringing Research Careers into Focus: An MRC Review of Next Destinations.* https://www.mrc.ac.uk/publications/browse/mrc-review-of-next-destinations/

78. http://www.insight.mrc.ac.uk/2015/03/18/science-doesnt-only-need-sprinters/

Barriers to progression for clinical academics

Issues related to workforce planning in the clinical world can impact upon the ability of clinicians to pursue research careers, and it is recognised that it is becoming increasingly difficult for individuals to balance clinical training with research.[79] However, the cadre of clinical scientists who take research from bench to bedside are critical for the UK's research base. In 2015, the MRC led the first comprehensive cross-funder survey of past clinical fellows to understand the routes by which people first become interested in academic clinical careers, the career pathways they pursue, and any barriers and enablers which hinder or help them along the way. The table below highlights the main blockers and enablers.[80]

Table 3: Blockers and enablers to pursuing a clinical academic research career

Blockers	Enablers
Encountered • Securing funding. • Mentoring. • Experience and skills gained through research. **Desired** • Increased/more funding. • Greater job security. • Clearer career paths. • Greater flexibility in the clinical training model. • Better careers advice/guidance. • Greater availability of formal mentorships. • Greater integration and better support across clinical and academic departments/supervisors. • A larger number/variation in clinical and academic job roles and training positions.	• Maintaining research activity. • Difficulties surrounding funding. • Financial implications of pursuing a clinical academic career. • A lack of clarity on career aspirations and routes. • Work/life balance. • Family commitments. • The availability of positions. • (Re)location. • A lack of support by host institutions/supervisors. • Contractual issues. • Gender issues.

One of the recommendations of the MRC's study was for those involved in supporting clinical academic research careers to work together to agree principles and guidance to support clinicians engaged in clinical academic pathway training. This has been addressed recently by funders and other stakeholders who have worked together to develop a **set of principles and obligations** outlining what they expect from those responsible for clinical training, from trainees and funders across the UK.[81]

Employment benefits are a crucial issue addressed by these principles, which state that the rights of clinical academics with continuous employment must be protected, even when they change their employer from an NHS trust or board to an academic institution, and vice versa. These rights include as a minimum all family and care-related leave and pay, as well as sick leave and pay. These principles and obligations will have a UK-wide impact. Partners are working to collectively evaluate the impact of this work on an ongoing basis, and will include the principles in the terms and conditions of their relevant grants.[82]

79. https://www.rcplondon.ac.uk/projects/outputs/research-all

80. MRC (2015). *A Cross-Funder Review of Early-Career Clinical Academics: Enablers and Barriers to Progression.* https://www.mrc.ac.uk/documents/pdf/review-of-early-career-clinical-academics/

81. https://wellcome.ac.uk/sites/default/files/ClinicalPrinciples_and_Obligations_170112.pdf

82. The Academy of Medical Sciences (2017). *Improving support for clinician researchers: new UK wide principles launched.* https://acmedsci.ac.uk/more/news/improving-support-for-clinician-researchers-new-uk-wide-principles-launched

4.3 How graduate students and postdoctoral researchers are funded

PhD funding

Most funders in the UK run a **programmatic model of funding PhD studentships** where block grants are provided to HEIs and research institutes to recruit students. This model can offer benefits such as:

- Providing HEIs and research institutes with flexibility in the use of funds to support postgraduate studentships aligned to their scientific strategy and strengths.
- Training PhD students in a cohort with access to additional training and mentorship guidance.
- Enabling programmes to set a mandatory requirement for doctoral candidates to participate in flexible professional internships during their PhD to widen their experience beyond academia and support employability.

Research Councils issue block grants to particular HEIs via:

- **Centres for Doctoral Training**, such as those funded by the EPSRC. These provide training for students within focused research areas, often defined strategically by the Research Council funder from the outset. Centres can be focused on academic or industrially relevant research topics, or a combination of both.[83]
- **Doctoral Training Partnerships**, such as those funded by the MRC or BBSRC. These provide training for students across a broad range of subjects determined by a research organisation or consortia of research organisations. Currently, approximately 45% of the MRC's studentships are supported via these partnerships.[84] Since 2016, the MRC has been providing fewer, but larger, more flexible partnerships.
- **Industrial CASE** – See box 4

Wellcome's four-year PhD Studentships in Science scheme offers students in-depth postgraduate training via 32 programmes throughout the UK. Wellcome is currently undertaking a major review of its approach to basic and clinical PhD training provision. The review's findings are expected to be published in summer 2018.

While most programmatic models are increasingly designed to recruit the best students, and then to match the student with the project, some research charities also support individual PhD studentships whereby applications are made by prospective supervisors with or without a named student. Examples include the ARUK PhD scholarship scheme and the BHF's non-clinical PhD studentships.[85,86]

There are a number of funded PhD schemes **(Clinical Research Training Fellowships)** that support clinically active doctors to undertake a full-time higher research degree. Funding bodies such as the MRC[87], Wellcome, and the BHF offer these awards with differing eligibility requirements. Generally, they are expected to conduct their research training full-time and either take a formal break from clinical training or maintain minimal clinical activity during the fellowship for the duration of the PhD.

In autumn 2015, Wellcome made the strategic decision to support clinicians wishing to gain research training entirely through an expanded portfolio of clinical PhD programmes, a number of which are multi-institutional.[88] The move from individual studentships to programmes for clinical PhDs brings it into alignment with Wellcome's non-clinical PhD programmes. At the same time, Wellcome acknowledges the need to support standalone fellowships as part of the wider offering. In circumstances where clinicians are not very mobile, individual fellowships can give them the flexibility they require to pursue their research. To address this issue, Wellcome has entered into a partnership with the MRC to fund up to five clinical PhDs as part of the MRC's Clinical Research Training Fellowships scheme.

83. QAA (2015). *Characteristics Statement: Doctoral Degree.* http://www.qaa.ac.uk/en/Publications/Documents/Doctoral-Degree-Characteristics-15.pdf
84. https://www.mrc.ac.uk/documents/pdf/doctoral-training-partnerships-2015-guidance-notes/
85. http://www.arthritisresearchuk.org/research/information-for-applicants/types-of-grant/phd-scholarship-2018.aspx
86. https://www.bhf.org.uk/research/information-for-researchers/what-we-fund/phd-studentships
87. https://www.mrc.ac.uk/skills-careers/fellowships/clinical-fellowships/clinical-research-training-fellowship-crtf/
88. Wellcome Trust (2015). *Director's Update: Refreshing our offer to clinicians.* https://blog.wellcome.ac.uk/2015/07/15/directors-update-refreshing-our-offer-to-clinicians/

While the NIHR's IAT Pathway is a common route for undertaking a PhD after medical school, many candidates not on the NIHR programme also conduct doctoral research. The University of Cambridge and University College London have well-established **integrated MB PhD programmes,** while Imperial College London and the University of Manchester have been running their programmes for less than 10 years.[89] These programmes allow a selected group of students to develop their basic science skills from BSc to PhD whilst completing their undergraduate medical education.

Funding for postdoctoral researchers

Working as a postdoctoral research assistant on a PI's research project is the most common option for postdoctoral researchers in the UK post-PhD. Most of these positions are funded either through three-year project or five-year programme grants which have been won by the PI. The length of these contracts can vary from a few months to three or more years. Postdoctoral research fellowship funding is also awarded on a competitive basis, using independent expert peer review. Some funders have criteria stipulating that the fellowship should not be held in the institution where the PhD was carried out.[90]

Schemes for re-entry

Many funders offer research career re-entry fellowships which give postdoctoral scientists the opportunity to re-establish their careers after a career break. Within the biomedical sciences, examples include Wellcome's Research Career Re-entry Fellowships, the BHF's Career Re-entry Research Fellowships, and the Daphne Jackson Fellowship. The Royal Society's Dorothy Hodgkin Fellowship is for scientists in the UK at an early stage of their research career who require a flexible working pattern due to personal circumstances such as parenting or caring responsibilities or health issues.[91]

A number of reports over the past decade have highlighted the lack of senior female biomedical researchers in the UK.[92,93,94,95,96] There has been a concerted effort to ensure representation of women researchers in the UK though the Athena SWAN Charter.[97] The Academy's SUSTAIN programme is designed for women early career researchers (including biomedical researchers with clinical and non-clinical qualifications) to support them along their career trajectory and in transitioning to senior leadership positions.

The year-long programme is of particular interest to women returning from a career break due to caring responsibilities, and offers interactive skills training and career development sessions, tailored mentoring, and the opportunity to network with research leaders. The scheme is currently funded by a consortium including the MRC, the Royal Society, and the Academy. Feedback from participants has been extremely positive so far and demonstrates the success of the programme.[98]

89. Barnett-Vanes A, Ho G & Cox TM (2015). *Clinician-scientist MB/PhD training in the UK: a nationwide survey of medical school policy.* BMJ Open **5.** http://bmjopen.bmj.com/content/5/12/e009852
90. https://www.bhf.org.uk/research/information-for-researchers/what-we-fund/immediate-postdoctoral-basic-science-research-fellowship
91. https://royalsociety.org/grants-schemes-awards/grants/dorothy-hodgkin-fellowship/
92. Medical Schools Council (2013). *A Survey of Staffing Levels of Medical Clinical Academics in UK Medical Schools as at 31 July 2012.* http://www.medschools.ac.uk/News/Pages/2012_Clinical_Academic_Staff_Survey_published.aspx
93. The UKRC (2009). *Female Attrition, Retention and Barriers to Careers in SET Academic Research.* https://www.wisecampaign.org.uk/uploads/wise/files/archive/female_attrition__retention_and_barriers_to_careers_report_08_12_09.pdf
94. The Royal Society of Edinburgh (2012). *Tapping all our Talents.* http://www.rse.org.uk/wp-content/uploads/2016/09/Tapping-talents-report_FINAL.pdf
95. National Research Council of the National Academies (2010). *Gender Differences at Critical Transitions in the Careers of Science, Engineering, and Mathematics Faculty.* The National Academies Press. Washington, DC. https://doi.org/10.17226/12062
96. Equality Challenge Unit (2013). *Equality in higher education: statistical report 2013.* http://www.ecu.ac.uk/publications/equality-in-higher-education-statistical-report-2013
97. http://www.ecu.ac.uk/equality-charters/athena-swan/
98. http://www.ecu.ac.uk/equality-charters/athena-swan/

4.4 Improving the structure of PhD training

The structure of PhD training

In contrast to most European HEIs, admission to PhD programmes in the UK can be on the basis of a bachelor degree, although increasingly either a research masters or an intercalated year of practical experience is required to be competitive. Unlike in the US, the period of study for a UK doctoral degree is usually three to four years full-time, with a very small taught component and modest or no teaching responsibilities. There is a long-term trend away from three-year PhD projects to four-year programmes although this has given rise to increased cost implications for research funders. Traditionally, the PhD in the UK has followed an apprenticeship model focused on delivering primary research under a supervisor, but in the past decade or so increased attention to research and generic skills training for all doctoral candidates has led to the PhD becoming more structured, especially in the earlier years of study.[99] In the 1+3 PhD programme structure, which is the norm for Research Council and Wellcome awards, students carry out laboratory projects in different laboratories in the initial rotation year. At the end of the year, students choose a thesis supervisor to complete their three-year PhD project.

Standardised guidelines for doctoral training

RCUK's Statement of Expectations for Postgraduate Training sets out common principles for the support of all Research Council-funded students and those funded by Wellcome, CRUK, and the BHF.[101] Doctoral training in the UK is perceived to be structured, with strict rules about admissions, supervisions, etc. and provides solid training in scientific method leading to the development of researchers who are qualified to contribute independently to advance science. In contrast, the Danish PhD model, for example, is research-based but also provides preparation for employment outside of academia, with a focus on 'course work' and activities not directly related to the PhD project. The monograph model of thesis writing (as is the norm in the UK) is generally viewed by UK stakeholders to have an advantage over the Nordic example of thesis by publication because of the length of time it takes to publish papers, and also because of the difficulty in publishing negative results. Stakeholders have debated whether the UK bioscience community should require more exact and standardised guidelines from all PhD funders. ORPHEUS (Organisation of PhD Education in Biomedicine and Health Sciences in the European System) have advocated a European-wide PhD model for biomedicine and health sciences, and an increasing number of member institutions have agreed to the model.[101]

Training for diverse careers

The number of PhDs awarded every year increased by 40% between 1998 and 2008 in OECD countries. In the UK, growth has been fuelled by overseas doctoral students.[102] As part of its Industrial Strategy, the government recently announced a National Productivity Investment Fund to support an additional 1,000 PhD studentships starting on 1 October 2017. In the US, increasing internationalisation of the workforce is evident at all research levels starting from PhD students and postdoctoral researchers to full professor, and similar trends are observed in the UK.[103]

99. QAA (2015). *Characteristics Statement: Doctoral Degree.* http://www.qaa.ac.uk/en/Publications/Documents/Doctoral-Degree-Characteristics-15.pdf

100. RCUK (2016). *Statement of Expectations for Postgraduate Training.* https://www.ukri.org/files/legacy/skills/statementofexpectation-revisedseptember2016v2-pdf/

101. http://orpheus-med.org/index.php/latest-news-and-events/279-london-17-september-orpheus-vice-president-represents-orpheus-at-conference-on-the-future-of-the-uk-phd

102. Cyranoski D, et al. (2011). *The PhD factory.* Nature **472,** 276-279. http://www.nature.com/news/2011/110420/pdf/472276a.pdf

103. Science Policy Research Unit (2015). *International Careers of Researchers in Biomedical Sciences: A Comparison of the US and the UK.* https://www.sussex.ac.uk/webteam/gateway/file.php?name=2015-09-swps-lawson-et-al.pdf&site=25

Even though a PhD in biomedical science provides training in a wide range of skills, early career researchers are often poorly prepared for a life outside of academia, lacking awareness of their career options and the many transferable skills they have.[104] There is an increasing recognition that, due to the small number of postdoctoral roles compared to PhD opportunities, many students will not continue in an academic scientific discipline. UK research funders offer some training to address this issue, but there is still an ongoing debate about whether the primary responsibility of enhancing the future employability of graduates for careers outside of academic research lies with HEIs rather than funders. Examples of schemes provided by funders are outlined in box 2.

Box 2. Schemes to prepare researchers for diverse careers

Collaborative doctoral training such as **Industrial CASE studentships** (formerly known as Collaborative Awards in Science and Engineering) provide support for students to work in collaboration with a non-academic partner and offer experience of at least two distinct research cultures. Students spend a period of time with the non-academic partner (usually no less than three months over the lifetime of the PhD).[105]

The **Professional Internship for PhD Students (PIPS)** is a key component of BBSRC's Doctoral Training Partnership (DTP) programme. This three-month integrated placement provides DTP PhD students with the opportunity to carry out a work placement unrelated to their doctoral research during their PhD.[106]

The Academy of Medical Sciences runs three-month **policy internship schemes** for PhD students who are funded by Wellcome or the MRC. The scheme is designed to give students first-hand experience of the medical science policy environment, to gain insights into how research can impact on policy, and to build valuable networks with the UK's most eminent medical scientists and key science and health stakeholders.[107]

4.5 Plugging gaps in strategic areas

Skills valued by employers

Businesses across the UK need increasingly skilled employees as technologies, services and markets evolve.[108] They also value people with broad-based skills rather than with the academic tendency to increasingly sub-specialise. The Association of the British Pharmaceutical Industry (ABPI) found that in the life sciences sector there are major skills gaps in mathematical and computational areas, as well as long standing shortages in areas such as translational medicine, medicinal chemistry and clinical pharmacology.[109] Consequently, the ABPI recommended that the pipeline for the development of appropriate mathematical skills must be considered, and should include extending opportunities for students to study maths alongside

104. Riddiford N (2016). *Young scientists need to fight for their employment rights.* The Guardian, March 21. https://www.theguardian.com/higher-education-network/2016/mar/21/young-scientists-need-to-fight-for-their-employment-rights

105. https://www.mrc.ac.uk/skills-careers/studentships/how-we-fund-studentships/industrial-case-studentships/

106. http://www.bbsrc.ac.uk/skills/investing-doctoral-training/pips/

107. https://acmedsci.ac.uk/about/administration/internship-schemes

108. CBI (2016). The right combination: *CBI/Pearson education and skills survey 2016.* http://www.cbi.org.uk/cbi-prod/assets/File/pdf/cbi-education-and-skills-survey2016.pdf

109. The Association of the British Pharmaceutical Industry (2015). *Bridging the skills gap in the biopharmaceutical industry: Maintaining the UK's leading position in life sciences.* https://www.abpi.org.uk/media/1365/skills_gap_industry.pdf

science subjects post-16, universities putting increased emphasis on maths in bioscience courses, and raising awareness and uptake by graduates of masters and PhD level training in statistics, data mining, mathematical modelling and related disciplines.[110]

Skills gaps in bioscience

Research funders in the UK have wrestled with issues around the undersupply of trainees in certain areas. For example, the BBSRC and the MRC undertook a review to identify vulnerable capabilities and skills within the UK bioscience and biomedical research base.[111] In consultation with academia, businesses and other research organisations, skills and capabilities within the following five areas were highlighted:

- Interdisciplinarity
- Maths, statistics and computation
- Physiology and pathology
- Agriculture and food security
- Core research and subject specific skills

In response to the review, the BBSRC set up its **Strategic Training Awards for Research Skills** scheme. This scheme provides c.£150,000 over three years for postgraduate-level training of around 400 scientists, in areas of significant need in clearly defined academic and industrial sectors, including bioinformatics and computational biology skills, entomology and plant pathology training and mathematical biology training.[112] The MRC decided to ask research organisations in receipt of DTP funding to focus on very strong training in skills priority areas as identified in the review, including supporting individuals to undertake Advanced Course Masters Training in areas of MRC skill priorities.[113]

Skills gaps in clinical research

In clinical academic research, the NIHR has started building research capacity in priority areas by changes to the allocation of ACF and CL posts (in addition to funding these posts through the response mode model). These posts can be linked to health challenges such as dementia, technical challenges such as bioinformatics, and service challenges such as social care.

Since 2000, the Medical Schools Council has undertaken a regular survey of clinical academic staffing levels in UK medical schools. The Council's latest survey identifies concerns which include: specialties vulnerable to changes in academic staffing levels (such as emergency medicine and pathology), and the ageing clinical academic population. There is an imbalance between the incoming group (lecturers) and those who are likely to retire in the next 10 years and this may represent a manpower problem in future years.[114]

As part of the UK government's Industrial Strategy, an independent review of the life sciences sector has recommended a reinforced skills action plan. This should be based on a gap analysis of key skills for science that considers areas for future focus across the clinical and academic sectors, and industry.[115]

110. *Ibid.*

111. https://www.mrc.ac.uk/documents/pdf/review-of-vulnerable-skills-and-capabilities/

112. http://www.bbsrc.ac.uk/news/people-skills-training/2016/160126-n-first-stars-awards-target-vulnerable-skills-life-sciences/

113. https://www.mrc.ac.uk/documents/pdf/doctoral-training-partnerships-2015-guidance-notes/

114. Medical Schools Council (2016). *A Survey of Staffing Levels of Medical Clinical Academics in UK Medical Schools as at 31 July 2015.*

115. https://www.gov.uk/government/news/sir-john-bell-to-unveil-industry-led-proposals-to-build-uks-status-as-world-leader-in-life-sciences

5. Industry and research careers

The UK life sciences sector is unique in that it is able to draw on world class universities, a strong pharmaceutical and biotechnology sector, and one of the largest single national healthcare systems in the world (the NHS). As noted in **section 1,** the pharmaceutical industry is the UK's biggest investor in R&D at £4.2 billion equating to 20% of total R&D expenditure.

The importance of collaboration across academia, industry and the NHS in driving innovation in the medical sciences is well recognised. Charities are looking to maximise their impact by developing partnerships with industry (often through public–private partnerships) that encourage the translation of research 'from bench to bedside'. Academic Health Science Networks are bringing together local NHS organisations, universities, industry, local authorities and charities, to drive translation of research and innovation in the NHS. Two examples of key players supporting strategic research partnerships between businesses and universities in the UK are: the **Research Councils** and **Innovate UK** (the government's innovation agency through which business-led innovation is incentivised). The UK enjoys an excellent reputation for innovation but it is not strong in the uptake and adoption of innovation and driving it all the way through to commercially successful ventures, particularly in comparison to the US and China.[116] There is a need to develop a workforce skilled in taking an innovation to a commercial entity.[117]

116. Council for Science and Technology (2015). *Science Landscape Seminar Reports: Life Sciences and Medical.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/435204/8-science-landscape-seminar-life-sciences-and-medical.pdf
117. The Academy of Medical Sciences (2010). *Academia, industry and the NHS: collaboration and innovation.* https://acmedsci.ac.uk/file-download/35209-Collabor.pdf

One of the key findings of the UK government-commissioned Dowling Review was that **people are central to successful collaborations.**[118] The study noted that strong trusting relationships between people in business and academia form the foundation for successful collaboration. Collaboration can be fostered by creating an incentive framework for universities and businesses which promotes cross-sectoral mobility of ideas and people, and by providing the opportunity to learn skills that are required for collaboration. his includes understanding the motivations of different sectors and supporting students to develop business awareness at an early stage of their research careers. It also includes continuing to fund schemes which support academia-industry mobility and ensuring that researchers who are successful in collaboration are valued in terms of career progression and assessment of research output.[119]

5.1 The role of industrial actors in supporting research careers

The breadth of collaboration between the biopharmaceutical industry and academia in the UK ranges from one-to-one collaborations that share compounds, data, or funding, through to large-scale international consortia.[120] In the UK, the pharmaceutical industry continues to represent an important employer for high-value jobs. It offered 62,000 jobs in 2015, with 24,000 of those dedicated to R&D.[121] Between 2006 and 2015, the pharmaceutical industry published over 16,000 publications in collaboration with UK scientists. Recent research shows a shift from in-house drug discovery employment in large pharmaceutical companies in the last five years, to increased employment in smaller and mid-sized companies, CROs, and academia, due to the downsizing of in-house drug discovery in big pharma. The impact of this shift on skills, experience, and leadership development is still unclear and merits further investigation.[122]

The UK pharmaceutical industry continues to provide industrial training and experience to undergraduates, graduates, postgraduates and postdoctoral researchers through placements, funding and support for a variety of research projects either at their own R&D sites or within an academic environment. For academics, the benefits of collaboration with industry include access to specialist equipment and data, a greater understanding of real-world problems and industrial challenges, increased job prospects, and new funding avenues.[123] The figure below, reproduced from the ABPI report, 'Developing talent and partnerships to create new medicines', shows trends in the number of R&D undergraduate industrial placements, PhD studentships, postdoctoral collaborations and academic posts from 2007 to 2015 (figure 4).[124]

118. *The Dowling Review of Business-University Research Collaborations (2015).* http://www.raeng.org.uk/policy/dowling-review/the-dowling-review-of-business-university-research

119. *Ibid.*

120. The Association of the British Pharmaceutical Industry (2016). *Collaborating for innovation. ABPI LINC: Library of Initiatives for Novel Collaborations.* https://www.abpi.org.uk/media/1341/linc-handbook-collaborating-for-innovation.pdf

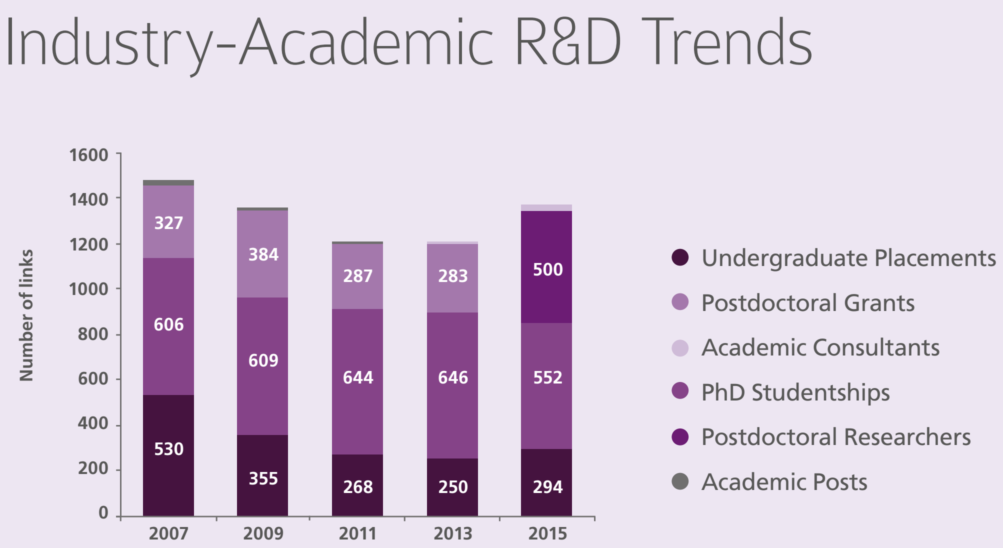
121. The Association of the British Pharmaceutical Industry (2016). *Open for Innovation: UK Biopharma R&D Sourcebook 2016.* https://www.abpi.org.uk/media/1358/open_for_innovation_abpi_sourcebook_2016.pdf

122. The Association of the British Pharmaceutical Industry (2016). *The Changing UK drug discovery landscape.* http://www.abpi.org.uk/about-us/resources/publications-library/the-changing-uk-drug-discovery-landscape

123. The Association of the British Pharmaceutical Industry (2016). *Developing talent and partnerships to create new medicines.* http://www.abpi.org.uk/media/1325/developing-talent-and-partnerships-to-create-new-medicines.pdf

124. *Ibid.*

Figure 4: Trends in the number of R&D undergraduate industrial placements (IPs), PhD studentships, postdoctoral collaborations and academic posts from 2007 to 2015.



Note: Up until 2015, ABPI members were asked to provide the number of postdoctoral grants held in 2015 it was the number of individual postdoctoral researchers sought. Academic posts include visiting professors and fellows. Adapted with permission from the ABPI.

The most recent ABPI longitudinal industry-academic links survey found an increase in undergraduate industrial placements in R&D. In contrast, the number of PhDs supported by industry is at its lowest level since 2003. This is because the supervisory capacity within UK pharmaceutical companies has decreased as companies have closed or downsized R&D sites. There are concerns that the move towards Research Councils funding PhDs through Doctoral Training Centres makes it more difficult for companies to closely engage with students.[125]

5.2 Partnerships with industry

The number of major collaborative projects and initiatives is increasing as industry shifts towards long-term open partnerships with academia, charities and other funders. Such collaborations support mobility of researchers across career stages. There are a number of UK-wide schemes that exist to promote mobility between industry and academia (see **online annex B** for a list of examples of existing schemes/programmes). There are different models of mobility schemes ranging from PhD studentships, postdoctoral fellowships to sabbaticals and visiting professorships for more senior researchers. Schemes such as the Royal Society's Industry Fellowship support the mobility of scientists working on collaborative research projects, allowing academic researchers to spend time in industry and vice versa (online annex B, table 1).

125. *Ibid.*

Schemes driven by industry include GSK's Esprit R&D which started in 2013 and is a three-year global development programme open to internal and external physicians, PhD chemists and biologists. GSK have had 38 associates on the programme; 19 have left since 2015, of which 74% secured a role that was a promotion. Innovate UK funded the **Knowledge Transfer Partnerships (KTP) scheme,** which is supported by the Research Councils and enables early career researchers to transfer knowledge between a company and an academic organisation (online annex B, table 1). In 2011/12, for every £1 million of government money invested in KTPs, 30 new jobs were created and 279 company staff were trained. A recent report by the National Centre for Universities and Business highlighted that **joint university-industry research centres** such as GLAZGo in Glasgow are seen by universities and industry as highly effective in rewarding, and therefore enabling mobility as part of the academic career.[126] Whilst engagement of industry with academia has increased in recent years, it is still a challenge between industry and the NHS.

The Dowling Review noted the need for digital tools to facilitate the identification of potential research partners. The ABPI recently launched a database, **ABPI LINC (Library of Initiatives for Novel Collaborations).** The database allows academic researchers in the UK to search for open opportunities for collaboration with the biopharmaceutical industry. It can be searched by research stage (preclinical/clinical), type of collaboration or resource, disease area, or company.[127]

As there is greater engagement between academia and industry, it is essential that public concern regarding the **impact of potential conflicts of interest** is allayed. For example, we know from recent public dialogue work conducted by the Academy that the public has concerns about industry involvement in generating evidence on new medicines through research.[128] With increasing collaborations between academia and industry, there are concerns that commercial pressures may influence those working within the academic sector, though this is not limited solely to biomedical research. The Academy is encouraging increased openness around trials and collaborations involving industry and academia to improve confidence and promote good practice in industry–academia relationships that generate evidence.[129]

5.3 Barriers preventing movement between sectors

The key to a successful research career is the ability to move between different career paths, not least because positions of permanent employment are limited in the biosciences. Moreover, the translation of research, particularly from basic biosciences through to clinical application needs such 'bridge-crossers', i.e. researchers who are able to understand the aims, drivers, expectations, and cultures of the two sectors. Despite there being recognition of the benefits of mobility, barriers to cross-sectoral mobility for UK researchers exist, and these are outlined below:

- There is a **cultural gap between researchers working in industry, academia and the NHS.** For example, industry, generally, puts a higher premium on team working; whereas within academia, the incentives and recognition for collaborative work, particularly its impact on the likelihood of promotion, are not so well aligned.[130]
- The knowledge gap between industry-trained scientists and academics is enormous. Industry has a complete set of processes and language framework within which to work when developing medicines and devices, including procedures related to drug development and commercialisation, but academics and clinicians often have a poor understanding of these.
- The above point makes it difficult for industrial scientists to build credentials that are recognised as crucial indicators of career achievement such as a strong **publication record.** A paucity of publications leads to under-recognition by academia of the quality of the researcher, their science, and their potential contribution to carry out novel research and translate new research findings if they were to return to academia. For industrial scientists, re-entry into academia and the achievement of higher level accolades can be difficult in the UK.

126 National Centre for Universities and Business (2015). *The Exchange of Early Career Researchers between Universities and Businesses in the UK.* http://www.ncub.co.uk/reports/the-exchange-of-early-career-researchers-between-universities-and-businesses-in-the-uk.html

127. https://linc.abpi.org.uk/

128. The Academy of Medical Sciences (2016). *Medical Information Survey.* https://acmedsci.ac.uk/file-download/59091244

129. http://acmedsci.ac.uk/policy/how-can-we-all-best-use-evidence

130. Council for Science and Technology (2015). *Science Landscape Seminar Reports: Life Sciences and Medical.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/435204/8-science-landscape-seminar-life-sciences-and-medical.pdf

- A significant and successful industrial career is often hallmarked by patent filings (for chemists in particular) and review papers, commentaries, a significant conference speaking schedule, rapid promotion and increased portfolio responsibility (for biologists). These aspects are not appreciated as a representation of a significant research contribution and capability to foster collaborations.
- Cross-over is more unusual at senior career stages when there can be a perception that the gap between academia and industry is too large to bridge. There are fewer opportunities and examples of industry researchers making the move into or returning to academia.
- It is less common for clinicians undertaking PhDs and postdoctoral research to move between academia and industry compared with non-clinical researchers. NIHR-funded infrastructure such as Biomedical Research Centres ensures clinician scientists have sufficient time in their job plans to conduct research. However, outside of such centres, research programmed activities are often taken out of the job plans of clinicians to prioritise service delivery, making it much more difficult to gain research experience in industry or elsewhere.

Barriers that particularly affect early career researchers include:

- A **lack of appreciation for industry experience** in academic reward structures. Industry experience is seen as a substitute not as a complement to the academic career and is (dis)regarded accordingly (as discussed above).[131]
- The historical view that a **move to an industry career was deemed** by academic researchers **as a 'failure' or a 'loss'.** Academics often express concern that moving into industry might lead to a loss of contact with academic networks. Mentoring and support from senior academics is one way to help address this issue. For example, the Academy's mentoring scheme is offered to clinical fellows seconded to GSK's R&D sites, to encourage engagement between the sectors.[132] Significant senior level appointees from academia into industry have started to break the mould here and more fluidity should be encouraged. However, salary reductions for those returning to academia are sometimes considered a negative incentive.
- **Unclear career pathways for those spanning sectors,** as well as disciplines. Hybrid roles, such as AstraZeneca's Chief Scientists Programme (for individuals working half-time for AstraZeneca and half-time in an academic role) may offer one way forward.[133]

Despite the barriers, UK stakeholders (HEIs and businesses) are positive about recent trends in the image and the take-up of intersectoral mobility.[134] Cross-sector fertilisation is crucial to the success of UK plc and academic science. There is recognition that most projects today require multidisciplinary teamwork and with the UK exiting the EU there is enthusiasm to maximise the UK's own internal resources to work together and reach beyond UK borders to master international collaborations.

131 National Centre for Universities and Business (2015). *The Exchange of Early Career Researchers between Universities and Businesses in the UK.* http://www.ncub.co.uk/reports/the-exchange-of-early-career-researchers-between-universities-and-businesses-in-the-uk.html

132. https://acmedsci.ac.uk/grants-and-schemes/mentoring-and-other-schemes/mentoring-scheme

133. Council for Science and Technology (2015). *Science Landscape Seminar Reports: Life Sciences and Medical.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/435204/8-science-landscape-seminar-life-sciences-and-medical.pdf

134. National Centre for Universities and Business (2015). *The Exchange of Early Career Researchers between Universities and Businesses in the UK.* http://www.ncub.co.uk/reports/the-exchange-of-early-career-researchers-between-universities-and-businesses-in-the-uk.html

6. Outcomes

There are challenges in determining a full picture of the impact of the variety of programmes and initiatives provided by funders of biomedical research. This is partly due to a lack of national data collection and reporting on the biomedical workforce in the UK. In addition, many schemes launched in recent years are yet to generate sufficient data on their impact on careers. There is also a lack of general statistics held by research funders on the first career destinations after fellowships. Many funders have incomplete datasets on how many PhD students and postdoctoral researchers are funded by them. This is in part due to the practice of having a named lead PI on grants which creates an information deficit on the identities of postdoctoral researchers and other researchers supported by that grant. However, as summarised in the following sections, individual funders have collected some useful data on early career researchers that provides an indication of their career path.

A 2010 report by the Royal Society found that only a tiny proportion of science PhD students can expect to end up as university professors (0.45%).[135] The Academy is not aware of national data relating to the progression from lecturer to senior lecturer through to professor level for biomedical researchers. Sector-wide data analysis continues to be a challenge. Funders such as the MRC do not regularly track the career progression of their grant awardees, but conduct ad-hoc follow-ups of the next destinations of researchers 10–20 years after their MRC-funded awards. It is envisaged that the formation of UKRI, as a cross-Research Council group, might improve the collection of data in this area. The NIHR training review recommends that continual data collection and career progression should be tracked annually on an individual basis to facilitate evidenced-based decisions about career development needs and responses.

135 The Royal Society (2010). *The Scientific Century: securing our future prosperity.* https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2010/4294970126.pdf

Since 2014, the Research Councils and other funders have started using an online platform called researchfish to track the impacts of their investments. researchfish requires researchers to log the outputs, outcomes and impacts of their work.[136] This is now a mandatory requirement for all Research Council-funded award holders, but other funders have individual policies on whether submission is compulsory. It is a unique example of funders across a wide range of public and charity organisations, across all research disciplines, collaborating to define and agree a standard set of outputs to collect. Researchers input a wide range of information into the system including their peer-reviewed journal articles, the development of new products, the ways they may have influenced policy, trained other researchers, collaborated with academics and industry, etc.[137] As of April 2017 over 100,000 awards from over 100,000 researchers were being tracked in researchfish.[138]

The impact of medical research charity funding

The AMRC's 2017 impact report presents the first in-depth cross-sector analysis of the outcomes of the research funded by AMRC members.[139] Some key statistics and figures from the report are highlighted below:

The type and duration of awards

The vast majority of the 5,287 awards included in the report were awarded to universities (93%). The award grant types were as follows:

- 55% were awarded for projects.
- 20% for the support of people.
- 3% for infrastructure e.g. equipment.

Charities funded awards for a variety of durations from one to 16 years, with most awards being for three years. The time taken for an output to be produced in many cases was beyond the life of the grant.

Biomedical research funded by charities also leveraged further funding:

- Nearly two-thirds (64%) of the value of further funding was from government sources (for example the MRC or European Commission), providing an additional £1.3 billion.
- 25% of further funding was from charities or non-profit (for example Wellcome), providing an additional £530 million.
- 2% of further funding was from academic institutes or universities (for example the University of Oxford), providing an additional £40m.

Career progression[140]

The number of researchers moving into new positions per award was as follows:

- 66% of 1,075 awards had one team member move to a new position.
- 15% had two team members move to a new position.
- 19% had more than two team members move to a new position.

The types of researchers that moved into new positions were as follows:

- Many of the staff that moved came from early career positions (29% were students and 43% were postdoctoral).
    - 65% of these students and postdocs were continuing into academia.
    - 15% moved into private industry
    - 8% moved into healthcare.

136. https://www.researchfish.net/

137. RCUK (2016). *The UK Knowledge and Research Landscape: A report on available resources*. http://webarchive.nationalarchives.gov.uk/20180322124739/http://www.rcuk.ac.uk/documents/documents/ukknowledgeandresearchlandscapereport-pdf/

138. https://www.researchmedia.com/amrc/making-a-difference-impact-report-2017/introduction-and-context/

139. Many AMRC charity funders choose not to use researchfish and may gather their information on outcomes from research through different methods. The report contains data from 29% of the AMRC membership, and so does not completely represent the whole medical research sector as all charities differ vastly in the way and types of research that they fund.

140. https://www.researchmedia.com/amrc/making-a-difference-impact-report-2017/developing-the-human-capacity-to-do-research/

Where the researchers moved:
- 71% took positions within the UK.
- 6% took positions in the US.
- 13% took positions in countries across Europe.
- 89% continued in careers related to research.

6.1 The career destinations of biomedical doctoral graduates

Vitae's What do researchers do? survey provides an overview of doctoral graduates' early careers. The table below (table 4) demonstrates the position of biomedical doctoral graduates 3.5 years after graduation.[141]

Table 4: Early career progression of biomedical sciences doctoral graduates 2013

Position	Percentage of biomedical sciences doctoral graduates
Higher education research	16%
Teaching/lecturing in higher education	17%
Research outside higher education	13%
Other teaching occupations	3%
Other common doctoral occupations	36%
Other occupations	15%

RCUK's The impact of doctoral careers report found that compared to those from other disciplines, biomedical scientists are most likely to be working in the public sector (excluding those working in higher education). It is the only discipline where the proportion of public sector employment was higher than the private sector. This appears to be down to the number of biomedical doctoral graduates working for public healthcare bodies such as the NHS.[142]

6.2 The Career choices of non-clinical biomedical researchers

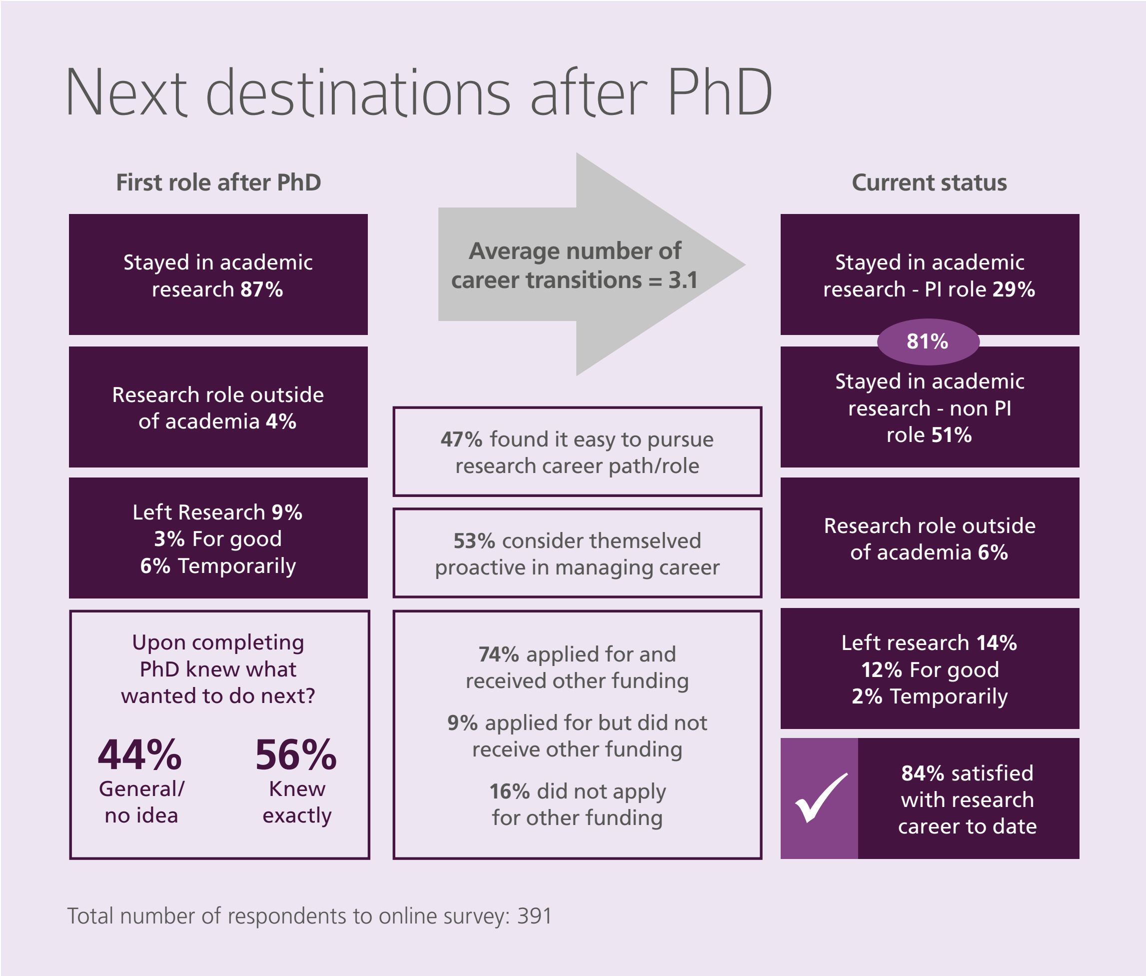
The MRC's review of next destinations of MRC-funded researchers found that the majority of respondents felt satisfied with their career and 87% were still working within research. Commonly held roles were as a PI or in a teaching/lectureship post. The figure below (figure 5) shows a summary of the career choices of respondents and shows their first role after completing their PhD along with their status at the time of the research.[143]

141. Vitae (2013). *What do researchers do? Early career progression of doctoral graduates.* https://www.vitae.ac.uk/vitae-publications/reports/what-do-researchers-do-early-career-progression-2013.pdf

142. CFE Research (2014). *The impact of doctoral careers.* https://www.ukri.org/files/legacy/skills/timodc-sb-summary-pdf/

143. MRC (2015). *Bringing Research Careers into Focus: An MRC Review of Next Destinations.* https://mrc.ukri.org/publications/browse/mrc-review-of-next-destinations/

Figure 5: Summary of career choices of respondents to the MRC review of next destinations.



Wellcome's Basic Science Career Tracker is an online survey that tracks the career destinations of key cohorts of Wellcome-funded researchers. Key findings from the latest survey (wave 6) include:

- The majority of Wellcome-funded four-year PhD programme students take a first position in academia (78%). A higher proportion of women leave academia immediately post-PhD. However, the difference between the proportion of men and women remaining in academia seems to decrease by three years post-PhD.
- There is evidence that the Sir Henry Wellcome Postdoctoral Fellowship scheme is helping to support researchers to launch independent careers in academic research. While the numbers are small, the vast majority (96%) of former fellows are to date employed in academia. In 2011 this scheme (for the UK only) and the biomedical Royal Society University Research Fellowships were subsumed by the Sir Henry Dale Fellowships, funded in partnership with the Royal Society. Sir Henry Dale fellows will be added to the next wave of the survey.
- The Wellcome Research Career Development Fellowships are also proving to be an important funding route to supporting independent academic research careers. A large proportion of former fellows have established an independent research career: almost all continue to be employed in academia, with an increasing number in senior positions and securing funding.
- Across all schemes, those pursuing careers outside of academia tend to work in science- and health-related jobs, with the majority working in biotechnology/pharma, medicine/healthcare, science communication/writing, scientific consultancy and science administration/policy. Of those working outside academia, 90% report that they are using their scientific training or background in their current job and 44% still conduct research, with 42% conducting applied research and 7% conducting basic research.[144]

144. Wellcome Trust (2015). *Wellcome Trust Basic Science Career Tracker: Results of wave 6 (2014).* https://wellcome.ac.uk/sites/default/files/wtp059281.pdf

6.3 The impact of funding on clinical academic careers

The **NIHR ACF** scheme was introduced 10 years ago to support the predoctoral research training of potential future clinical academics in England. This was in response to concerns about falling numbers of clinical academic trainees. A recent 10-year analysis of the career progression of ACF cohorts found that ACFs are perceived by the candidate population as attractive posts, with high numbers of applications leading to high fill rates. Undertaking an ACF post was shown to increase the likelihood of securing an externally-funded doctoral training award. The vast majority of ACFs move into academic roles, with many completing PhDs. Previous ACFs continue to show positive career progression, predominantly in translational and clinical research.[145] Similarly, next destination data for CLs show the majority of award holders carry straight on with a clinical academic track.

A recent **cross-funder review of early career clinical academics,** led by the MRC, found that the award of a fellowship has a strong positive correlation with progression to clinical academic leadership roles. For example, of past **Clinician Scientist Fellowship** awardees surveyed, 43% are either clinical professors or senior clinical fellows, 95% currently direct and lead their own research, and 85% have secured significant further funding. A majority of rejected fellowship applicants also continue to be engaged in research. Some find alternative routes to research leadership roles, and many have active roles in supporting research more generally.[146]

Wellcome's newly revamped **Clinical Research Career Development Fellowships** scheme has only had two rounds of applications so far, so it is too early to measure the impact of the scheme. It would be interesting to note in due course the impact of establishing this single, flexible fellowship scheme, a consolidation of two of its existing schemes.

A 2007 Academy study of **UK MB PhD programmes** found that the clinical and scientific achievements of the group met the expectations for high academic standards and that a large proportion of graduates will pursue a clinical academic career.[147] A review of the graduate outcomes of the University of Cambridge MB-PhD programme in 2012 found that most respondents (95%) considered that their academic career goals were facilitated by the programme. Sixty-eight of the 80 alumni had conducted further research, 63 (79%) were active in research, and 90% had explicit plans for further full-time research.[148]

It should be noted that most of these evaluations carried out by funders are not controlled and the allocations of these posts were not randomised. Additionally for some aspects of career progression there has been little change; for example, the number of senior posts has not really gone up to match the increased support in the middle.

145. Clough S, et al. (2017). *What impact has the NIHR Academic Clinical Fellowship (ACF) scheme had on clinical academic careers in England over the last 10 years? A retrospective study.* BMJ Open **7**:e015722. doi: 10.1136/bmjopen-2016-015722

146. MRC (2015). *A Cross-Funder Review of Early-Career Clinical Academics: Enablers and Barriers to Progression.* https://mrc.ukri.org/documents/pdf/review-of-early-career-clinical-academics/

147. The Academy of Medical Sciences (2007). MB PhD Programmes. https://acmedsci.ac.uk/file-download/34585-118466389595.pdf

148. Cox TM, et al. (2012) *The Cambridge Bachelor of Medicine (MB)/Doctor of Philosophy (PhD): graduate outcomes of the first MB/PhD programme in the UK.* Clinical Medicine **12**, 530–534. http://www.clinmed.rcpjournal.org/content/12/6/530.full.pdf+html

7. Conclusions

The historically diverse funding ecosystem in the UK has successfully stimulated world-leading biomedical research and fostered the growth of a talented research base. As described in this paper, the UK has benefitted from strategic government investment over the past two decades, an extremely well-resourced charities sector, and an enlightened industrial base that recognises the importance of external collaboration. Above all, the research culture that has evolved over centuries enables the UK to punch above its weight in terms of academic excellence.

In this paper, we have highlighted examples of how multiple funders are providing complementary postdoctoral research schemes to enable outstanding young investigators to transition to independence. Funders have a shared interest in ensuring research talent is nurtured, and their willingness to address barriers to career progression collectively has helped to reshape the career pathway. For example, schemes such as Clinician Scientist Fellowships have been created as a result of multiple funders coming together to make successful strategic funding interventions to address disincentives to pursuing a clinical academic career.

Similarly, the Academy's catalytic ability to broker consortium funding to develop strategic schemes is another example of coordination across the sector which reassures and instils confidence in aspiring researchers traversing the career pathway. Funders have also tackled structural and cultural barriers to career progression, such as protecting the rights of clinical academics with continuous employment, identifying skills shortages, and addressing the lack of flexibility in terms of eligibility criteria for fellowships. This culture of collaboration between funders and other key stakeholders in the UK creates a supportive environment in which researchers can thrive, and continues to evolve in the face of changing external factors.

Whilst progress has been made, there is clearly scope for funders to improve long-term data collection on the biomedical workforce and the impact of their investments to make informed decisions. This needs to be done in the context of a future research vision[149] so that schemes can be evolved to meet the aspirations of the UK government's Life Sciences Industrial Strategy and to inform workforce planning. One area of future focus could be to create opportunities to support researchers responding to a changing careers landscape, by promoting intersectoral mobility of researchers, and ensuring training in diverse careers beyond academia. There is a need to enhance the equality and diversity of the workforce, including by understanding the hurdles faced by women researchers and providing them with greater access to support and guidance throughout their research careers. Finally, there is a need for funders to regularly take a strategic view across the funding landscape to identify imbalances in the training portfolio and the provision of support for early career investigators.

149 Office for Life Sciences (2017). *Life Sciences: Industrial strategy.* https://www.gov.uk/government/publications/life-sciences-industrial-strategy

Annex 1: Abbreviations

ABPI: Association of the British Pharmaceutical Industry

ABPI LINC: Association of the British Pharmaceutical Industry Library of Initiatives for Novel Collaborations

ACF: Academic Clinical Fellow

AMRC: Association of Medical Research Charities

ARUK: Arthritis Research UK

BBSRC: Biotechnology and Biological Sciences Research Council

BEIS: Department for Business, Energy and Industrial Strategy

BHF: British Heart Foundation

CL: Clinical Lecturer

CRO: Contract research organisation

CRUK: Cancer Research UK

EPSRC: Engineering and Physical Sciences Research Council

EU: European Union

HEFCE: Higher Education Funding Council for England

HEI: Higher education institution

HESA: Higher Education Statistics Agency

IAT: Integrated Academic Training

ISSF: Institutional Strategic Support Fund

KTP: Knowledge Transfer Partnerships

MRC: Medical Research Council

NIHR: National Institute for Health Research

NHS: National Health Service

ODA: Official Development Assistance

OECD: Organisation for Economic Co-operation and Development

ORPHEUS: Organisation of PhD Education in Biomedicine and Health Sciences in the European System

OSCHR: Office for Strategic Coordination of Health Research

PI: Principal investigator

R&D: Research and development

RCUK: Research Councils UK

REF: Research Excellence Framework

UKCRC: UK Clinical Research Collaboration

UKRI: UK Research and Innovation

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