UK Landscape Review for Immunology Careers

1 Introduction and Aims of the Review

The mission of the British Society for Immunology (BSI) is to promote excellence in immunological research, scholarship and clinical practice in order to improve human and animal health. A key objective of the BSI is to support current and future generations of immunologists.

Providing support for a strong workforce in immunology research requires a thorough understanding of the landscape for careers in immunology. The overall aims of this landscape review were to:

- track the career development and destinations of people who have completed a PhD in an immunology-related topic in the UK
- analyse the UK's immunology workforce in academia

The analysis conducted through this review provides substantial information about the career trajectories of immunologists and the academic workforce in this field. This insight will inform the BSI's overall strategy, policy and influencing activities for supporting a strong workforce in immunology.

This analysis was prepared for the British Society for Immunology by Freshney Consulting.

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3 Executive Summary

- This analysis tracked the current roles of 651 individuals who had completed a PhD in the field of immunology in the UK between 1975 and 2015.
- 58% of individuals tracked were currently working in immunology research, with a further 16% involved in research roles in other subjects.
- 66% of thesis authors were currently working in the UK and 9% in another EU country. The USA was the most popular destination for PhD graduates who left the UK, with 10% working there.
- 51% of PhD graduates were currently working in academia, 6% in healthcare and 12% had joint positions as clinical academics within both academia and healthcare.
- Research training in immunology is important for UK based industry, with 17% of PhD graduates currently working in roles in biotechnology or pharmaceutical companies. Notably, GSK attracted a significant number of PhD graduates – more so than major universities such as Cambridge, King's College London, Barts and The London or Birmingham.
- Of those currently working in industry, 44% were in biotechnology and 26% in pharmaceutical companies.
- PhD graduates in academia or academia/healthcare worked in a wide range of fields, the most common being understanding the immune response, or tackling infectious, inflammatory or autoimmune diseases.
- In 2015/16, 68% of UK academic staff in immunology carried out research only and 30% conducted teaching alongside research.
- Whilst there are strong numbers of women working in immunology, they are less likely than men to attain senior positions in immunology.
- Women working in immunology are also less likely to attain senior positions than women working in many other disciplines within the range of medical science subjects selected for this analysis.
- Over 40% of academic staff working in immunology at Higher Education Institutions are from outside the UK, a higher proportion than in many clinical research disciplines. This highlights the UK’s ability to attract international expertise in this field and the importance of allowing the movement of such people. This figure should be monitored in future years to assess the effects of the UK’s departure from the European Union.
- In 2015/16, almost half (47%) of immunologists in academia received their salary funding from a medical research charity, Research Council or EU, a much higher proportion when compared to academics from across a wide range of medical and life science disciplines (32%).

4 Methodology

There are two main components to this review and the approaches for each are described below.

4.1 Tracking the career development and destinations of people who have completed a PhD in an immunology-related topic

The aim of this objective was to describe the career destinations of individuals who had completed a PhD in an immunology-related topic in the UK. The search method used was based on that described previously by RAND Europe, who conducted an analysis of the dementia research landscape[1] for the Alzheimer's Society. For the immunology analysis, a sample of researchers was selected, who had completed a doctoral degree between 1975 and 2015. After data cleaning, the current destinations of the thesis authors was tracked.

4.1.1 Obtaining and cleaning the data

The details of doctoral theses completed on topics related to immunology were obtained from the British Library's E-thesis online service (EThOS[2]) database. EThOS contains records for over 450,000 theses, covering most of the doctoral degrees awarded in the UK by 131 participating institutions. The database includes around 95% of theses awarded between 2000 and 2013, however coverage is lower for older theses, particularly those awarded before 1980.

2,660 thesis entries were retrieved from the EThOS database, selected through the appearance of the search terms 'immune' or 'immunology' in the abstract of theses awarded between 1975 and 2015. A random sample of 1,000 theses was selected for the analysis. Weightings were applied as described in table 1 to boost the number of theses awarded before 2000 in the sample, since coverage of these years was lower in the EThOS database.

Year	*Retrieved from EThOS*	*Weighting applied*	*Number in sample*
1975 to 1979	20	100%	20
1980 to 1989	43	100%	43
1990 to 1999	220	100%	220
2000 to 2009	664	54%	358
2010 to 2015	1713	21%	359
Total	2660		1000

Table 1 – Weightings applied when selecting 1,000 thesis entries from EThOS for analysis

Searching for the appearance of 'immune' or 'immunology' in thesis titles revealed more entries (4,005 from 1975 to 2016). However, many of these entries did not include an abstract, which would hinder classification of the field of research and verification within the immunology field.

[1] http://www.rand.org/pubs/research_reports/RR1186.html

[2] http://ethos.bl.uk/

The extracted data was checked to remove any theses that were not relevant. In total, 158 thesis entries were removed, where the subject area was considered to be not relevant to immunology.

The remaining, cleaned dataset contained the details of 842 authors. When tracking the thesis authors, 191 (23%) individuals could not be traced and were removed from the dataset. Therefore, 651 authors could be traced (77%), which compares well with the dementia research analysis conducted by RAND Europe, in which 55% of thesis authors were traceable.

23% of authors in the dataset could not be traced and the main reasons are likely to be:

- Individual's details not present on the internet
- individual with a common name e.g. 'John Smith'
- individual had changed their name e.g. following marriage

The cleaned dataset from EThOS included the following parameters:

- Thesis title
- Author
- Awarding Body
- Date of Award
- Abstract

The dataset was analysed to attribute to each author:

- Gender
- Thesis Topic, selected from the following categories
    - Infectious disease
    - Immune response
    - Vaccines
    - Inflammation & Autoimmune Disease
    - Animal Health
    - Oncology
    - Transplantation
    - Microbiology
    - Plant immunology

4.1.2 *Tracing thesis authors*

The following online tools and resources were used to trace the current roles and locations of thesis authors:

- PubMed https://www.ncbi.nlm.nih.gov/pubmed/
- LinkedIn https://www.linkedin.com
- ResearchGate https://www.researchgate.net/home
- Google https://www.google.co.uk/
- WorldCat http://www.worldcat.org/

The following online tools were also used, albeit to a much lesser extent, to trace thesis authors:

- ORCiD https://orcid.org/
- Pubfacts http://www.pubfacts.com/
- Google Scholar https://scholar.google.co.uk
- Xing https://www.xing.com

During the searching, data was collected to describe the following parameters:

- current job title; employer; country; and sector of activity (e.g. academia, industry, Healthcare, other).

Individuals were identified as being:

- 'active in immunology research'; 'active in research'; or 'not active in research'

Where Individuals were identified as being active in immunology research, their current subject area was described. Up to 20 minutes was allocated to track and identify each author.

4.2 Analysis of the immunology workforce in UK academia

Academia represents a major destination for researchers in immunology. The aim of this objective was to describe the roles and locations of individuals working in Higher Education Institutions in the UK during 2015/16. Data describing academic workforce numbers in immunology and related subjects was obtained from the Higher Education Statistics Agency (HESA). Appendix 1 describes the parameters used for this search.

5 Results - Destinations of people who have completed a PhD in an immunology-related topic

5.1 Extracted dataset - characteristics

5.1.1 PhD-awarding institution

The authors in the dataset had conducted their PhD research at 68 different Higher Education Institutes (HEIs) in the UK. The HEIs with the highest number of thesis authors in the dataset are shown in Figure 1.

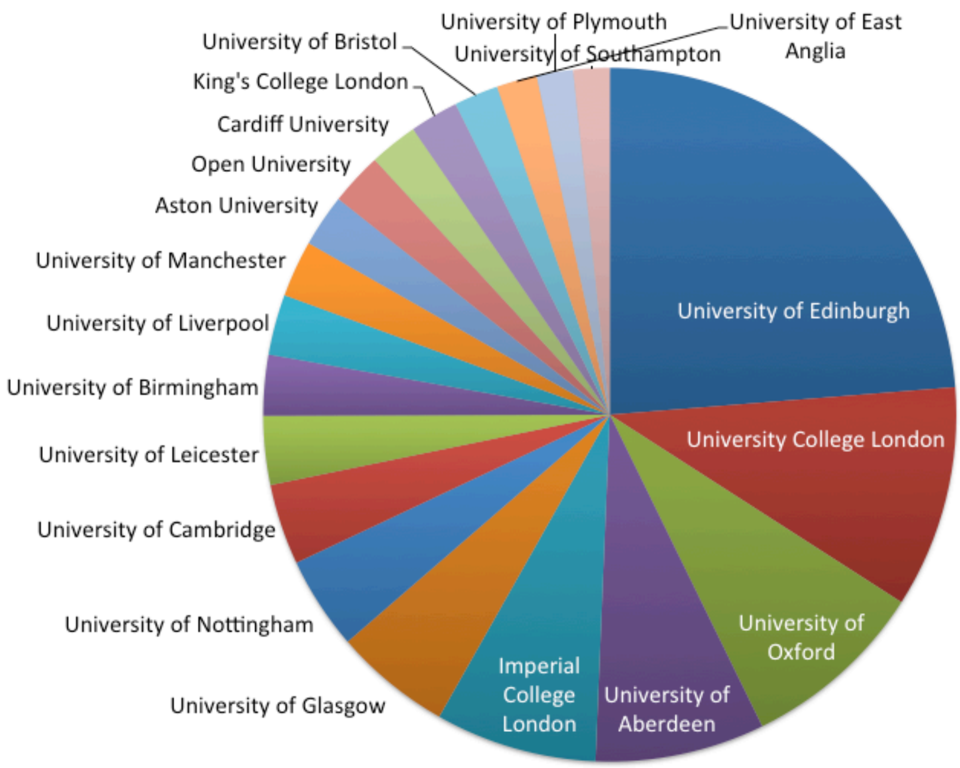

Figure 1 – Locations where thesis authors conducted their PhD research. The top 20 Higher Education Institutes (HEIs) are shown here, out of 68 HEIs in total; n=651

Analysis of the dataset indicates that universities such as Edinburgh appear to be quite highly represented in comparison to e.g. Cambridge, which was much lower. Variation exists in the EThOS dataset for a number of reasons. The University of Edinburgh is particularly well represented in the database because they have conducted a major retrospective digitisation project, endeavouring to make all their theses available. EThOS does not hold a large proportion of abstract details from PhDs completed at the major universities of Cambridge, Oxford and Imperial College London.

Whilst the institutional variation described above limits the ability to conduct institutional comparisons, it will have little effect on using this cohort to analyse the career destinations of PhD graduates in the UK.

5.1.2 PhDs awarded in each year

Figure 2 shows the number of PhDs awarded each year in the dataset. Of the 651 authors identified, 40% (n=259) received their PhDs between 2010-2015. The high coverage in later years is due to more abstracts being available in EThOS and also an increase in the number of people doing PhDs since 2000. Indeed, the British Library reports[3] that 54% of all PhD theses completed in the UK since the 19th Century were completed between 2000-2016.

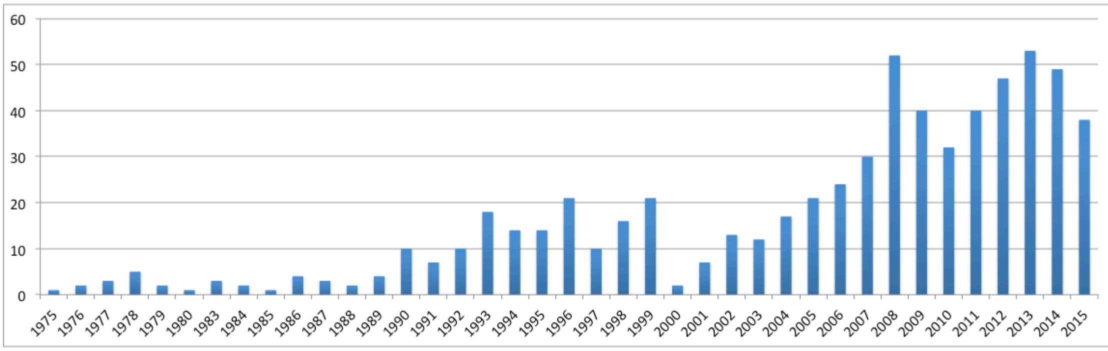

Figure 2 – Numbers of PhDs awarded each year (1975-2015) contained in the dataset (n=651). The low numbers seen in 2000 and 2001 were due to an inability to track a high proportion of thesis authors from these years.

5.1.3 Gender

55% of the authors in the dataset were male and 45% female

5.1.4 PhD thesis topic

The thesis title and abstract for each entry in the dataset was reviewed and the thesis assigned to a particular topic as shown in figure 3. The most common topics were Immune Response (29%), Infectious Disease (26%) and Inflammation & Autoimmune Disease (17%).

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[3] personal communication

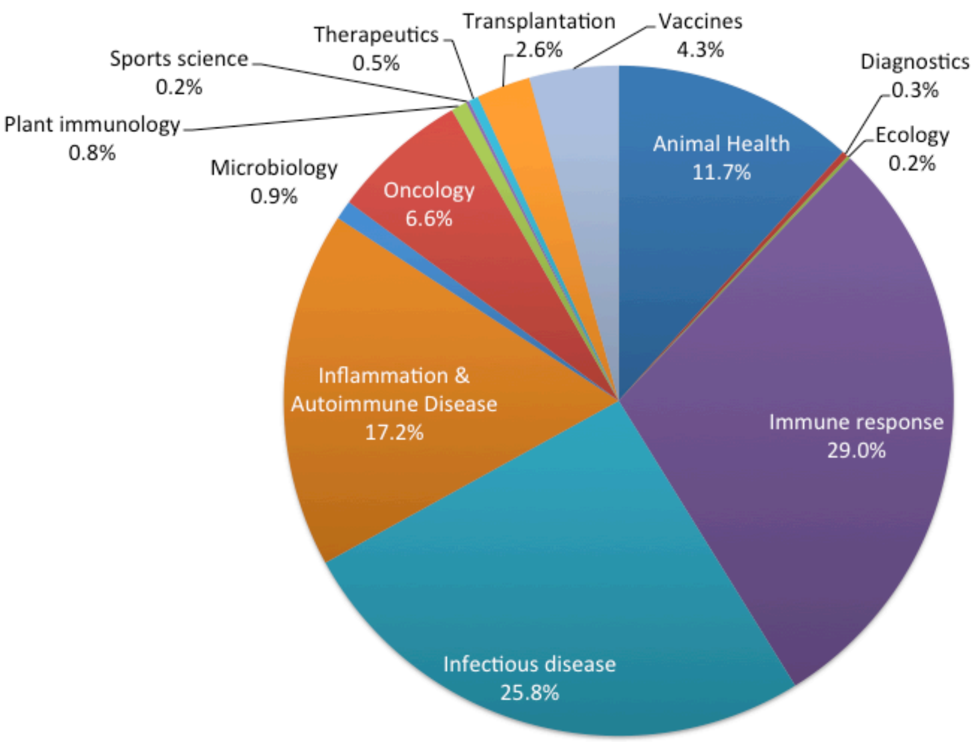


Figure 3 – Thesis subject field for each entry in the dataset (n=651)

5.2 Analysis of PhD authors – current destinations

The current destination of all PhD authors identified in the dataset was tracked as described in 4.1.2. The results of this analysis are described below.

5.2.1 Research activity

The current research activity of each author was classified as being:

- active in immunology research
- active in research (not immunology)
- not active in research

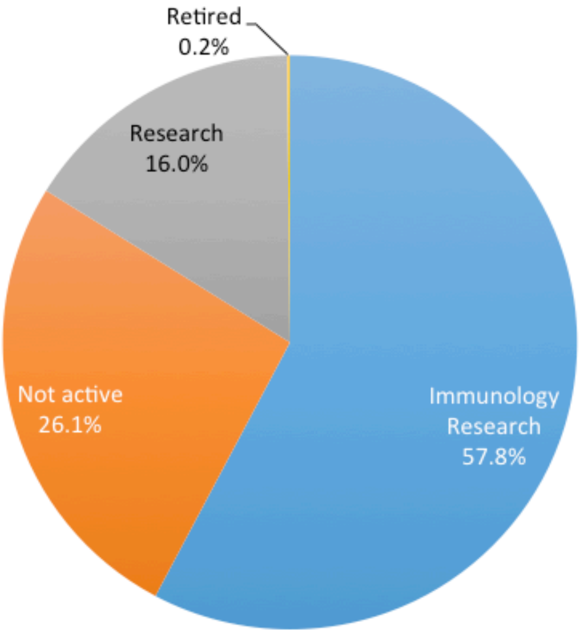


Figure 4 – Current research activity of each thesis author (n=651)

58% of thesis authors were currently working in immunology research, with a further 16% involved in research roles in other disciplines. In the analysis investigating careers in dementia, between 21% and 38% of dementia PhD graduates remained in careers in this field.

5.2.2 Current location

66% of thesis authors were currently working in the UK (figure 5). 9% were working in another EU country. The USA was the most popular destination for PhD graduates who left the UK, with 10% working there. 15% of graduates worked in a wider range of other non-EU countries (excluding USA).

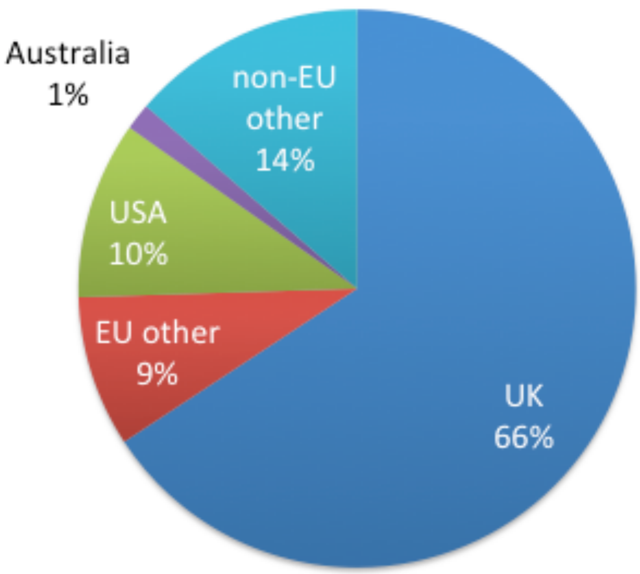


Figure 5 – Current destinations of PhD graduates (n=651)

Thesis authors were working in 59 different countries. The top 20 most popular current destinations are shown in table 2. A full list of all countries is shown in appendix 2.

Country	*No.*	*%*		*Country*	*No.*	*%*
UK	428	66%		Malaysia	5	0.8%
USA	67	10%		Saudi Arabia	5	0.8%
Australia	10	1.5%		Spain	5	0.8%
Canada	10	1.5%		Denmark	4	0.6%
Germany	10	1.5%		Greece	4	0.6%
Singapore	7	1.1%		Pakistan	4	0.6%
Ireland	6	0.9%		Sweden	4	0.6%
Italy	6	0.9%		China	3	0.5%
Taiwan	6	0.9%		France	3	0.5%
India	5	0.8%		Ghana	3	0.5%

Table 2 – Top 20 most popular current destinations of PhD graduates (n=651)

5.2.3 Current destination by sector

51% of PhD graduates were working in academia and 17% in industry (figure 6). 6% of graduates worked in healthcare and a further 12% had joint positions as clinical academics within both academia and healthcare.

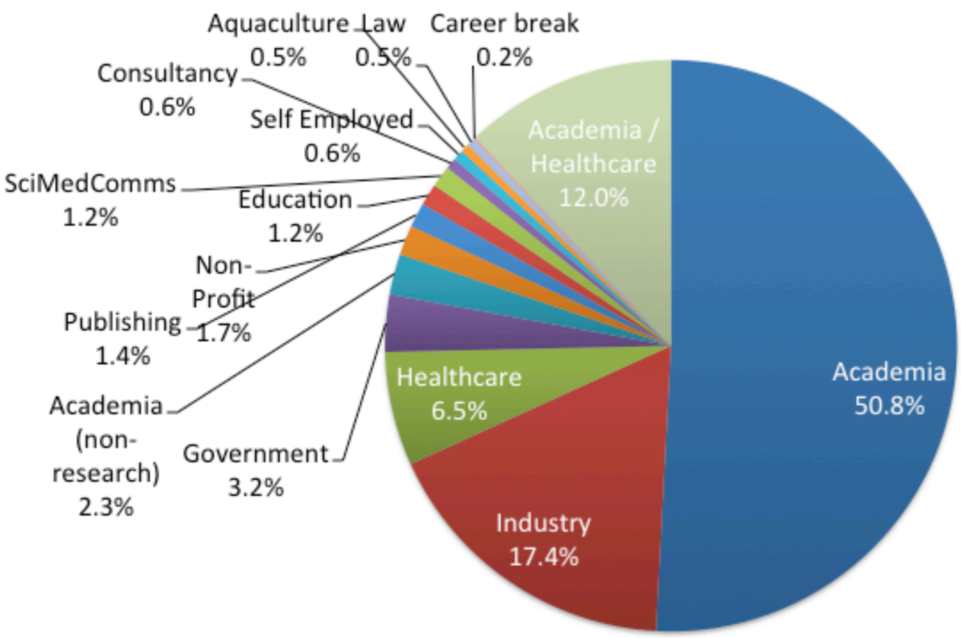


Figure 6 – Current destinations, by sector, of PhD graduates (n=651)

When looking at the industry sector in more detail (figure 7), the most common types of industry for PhD graduates to be working now were in biotechnology (44%) and pharmaceuticals (26%).

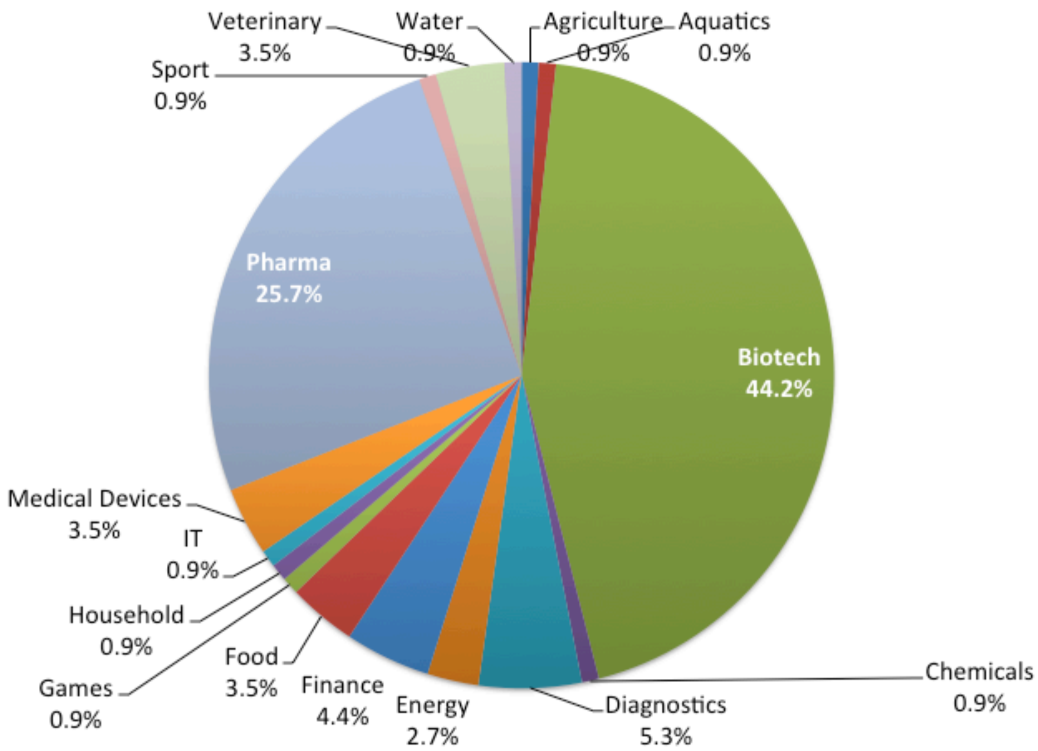


Figure 7 – Current destinations, within industry only, of PhD graduates (n=113)

5.2.4 *Types of current role*

In assessing the whole dataset, PhD graduates fill a wide range of current roles. In grouping these into roles of similar seniority by year, Postdoctoral Researcher roles were the most common for those completing PhDs since 2006 (figure 8).

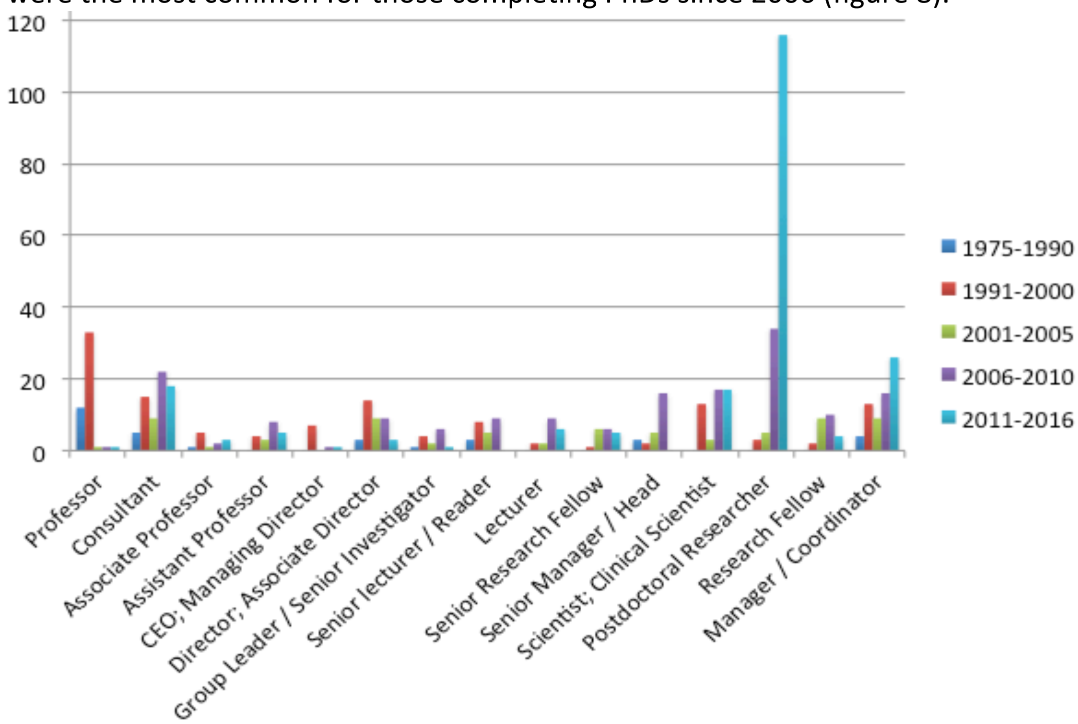


Figure 8 – Top 15 most common current roles for PhD graduates by year of PhD award. (n=599 in the top 15 roles)

5.2.5 Current destinations - organisations

The most common current destinations for PhD graduates in the dataset were UK universities, with the University of Oxford most popular (figure 9). However, it is also notable that a significant number of PhD graduates had joined GSK. This highlights the importance of immunology research skills to industry – see also section 5.2.3 describing 17% of PhD graduates who had moved to roles in the pharmaceutical or biotechnology industries. Such roles feed national prosperity and this data highlights the range and volume of non-academic alternatives.

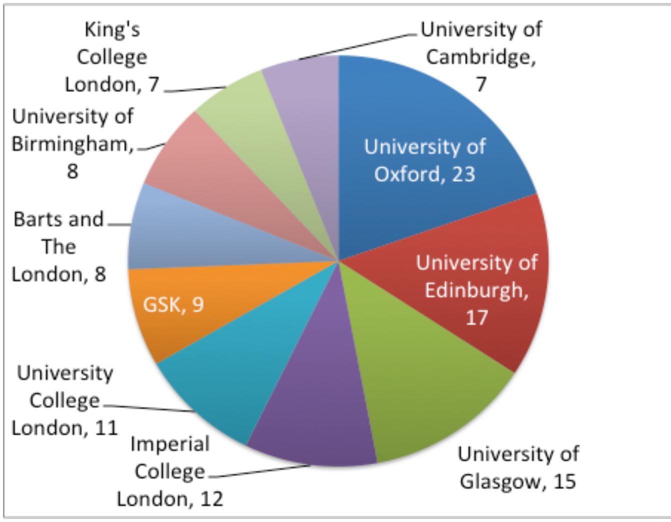


Figure 9 – Top 10 most common destinations - organisations (n=117 in the top 10)

5.2.6 Current research subject

Of the 651 authors in the cohort, 394 (63%) pursued a career in academia (including those with joint appointments in healthcare). Individuals currently conducted research into a wide range of current subjects, as shown in figure 10.

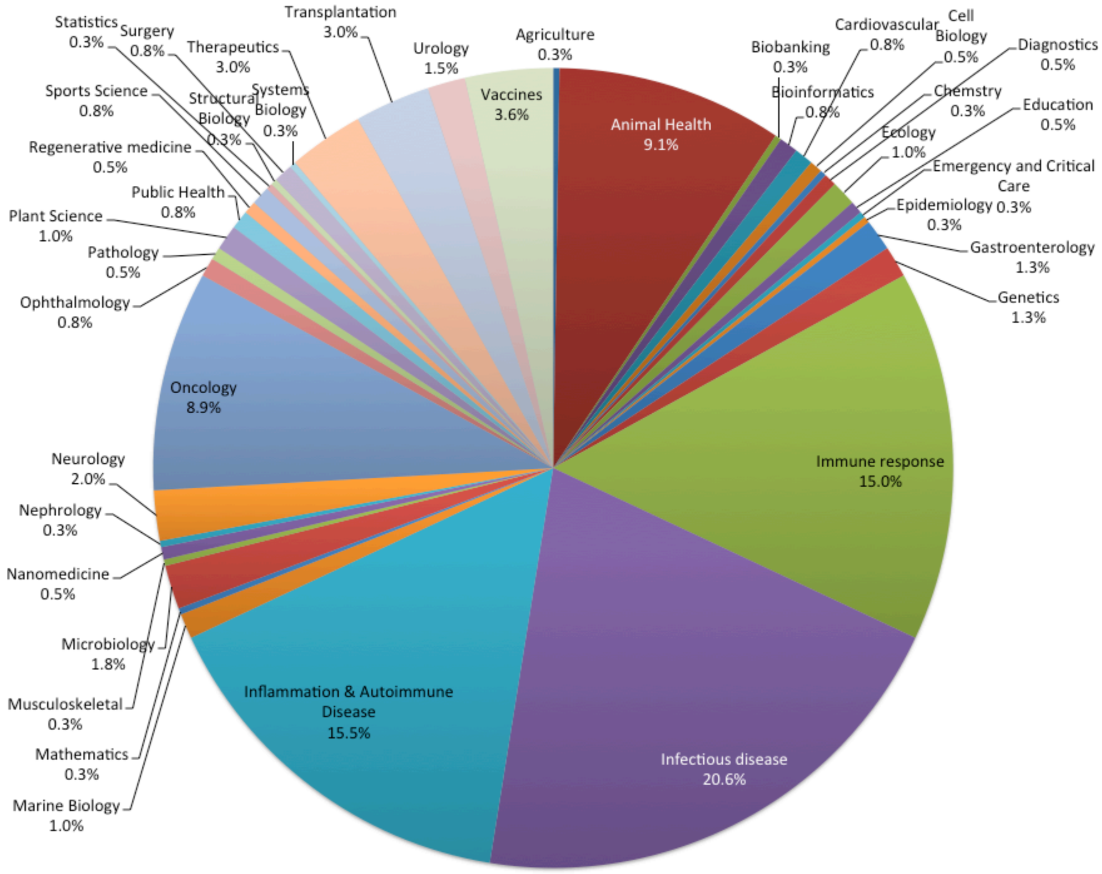


Figure 10 – Current research subject for PhD graduates working in academia or academia/healthcare (n=394)

6 Results - Analysis of the workforce in academia in 2015/16 using HESA data

6.1 Introduction

The aim of this objective was to describe the roles and locations of individuals working in Higher Education Institutions in the UK during 2015/16. Data describing academic workforce numbers in immunology and related subjects was obtained from the Higher Education Statistics Agency (HESA). 13,135 staff were contained in the dataset using the subject selection criteria. Appendix 1 describes the parameters used for this search.

6.2 Extracted dataset – characteristics

6.2.1 *Classification of academic staff by universities*

Analysis of the data from HESA indicated considerable variation in how Universities classified academic staff. For example, some universities such as UCL and Imperial College London classified a high proportion of staff in Clinical Medicine and low numbers in other medical or life science subjects such as immunology, cell biology and pathology (figure 11). In contrast, other universities e.g. Cambridge, Glasgow, Manchester and Oxford registered a good proportion of staff in these subjects.

This variation limits the analysis that can be done to compare institutions and it is likely that numbers of staff working in immunology are underrepresented in this analysis.

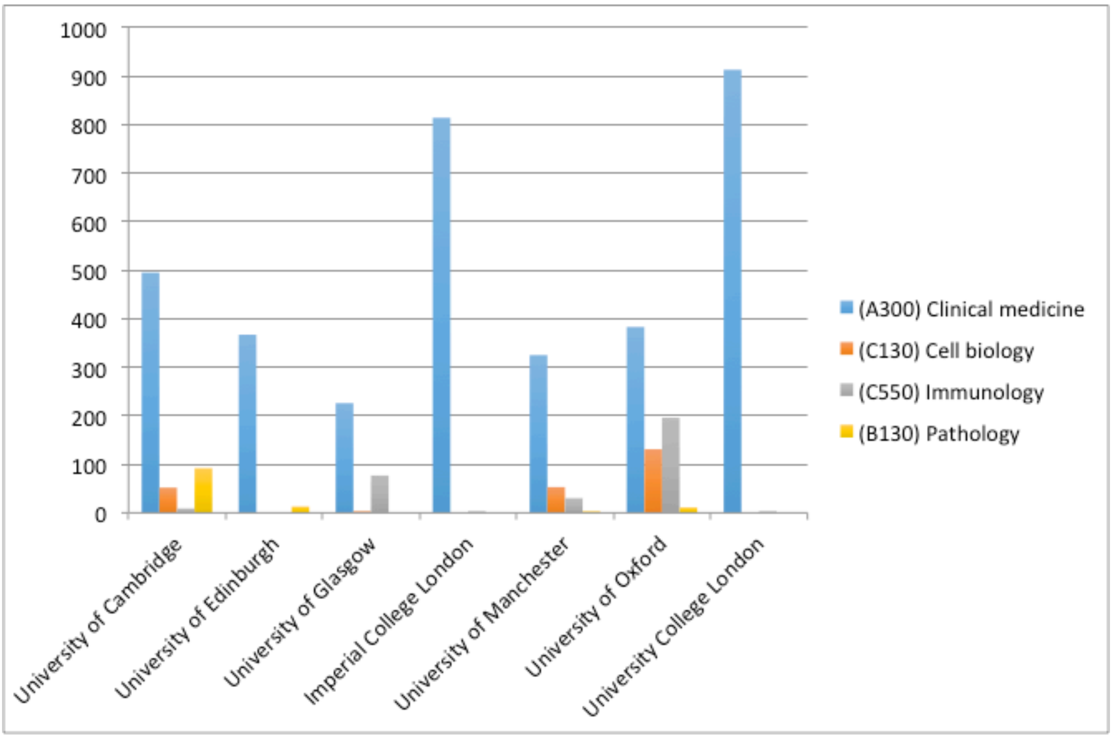


Figure 11 – Numbers of academic staff working in selected Current Academic Disciplines (CADs) at 7 universities (n=4195)

6.2.2 Academic staff - subject areas

The majority (53%) of staff in the dataset were classified in the field of clinical medicine (figure 12a). 5% of all staff in the dataset had immunology as their primary academic discipline. Figure 12b shows a more detailed description of the subject classification of all staff, excluding those in clinical medicine.

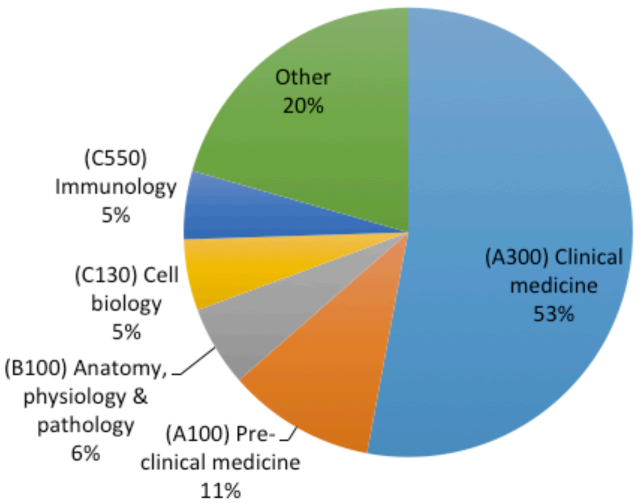


Figure 12a – Numbers of academic staff working in selected Current Academic Disciplines (CAD1; n=13135)

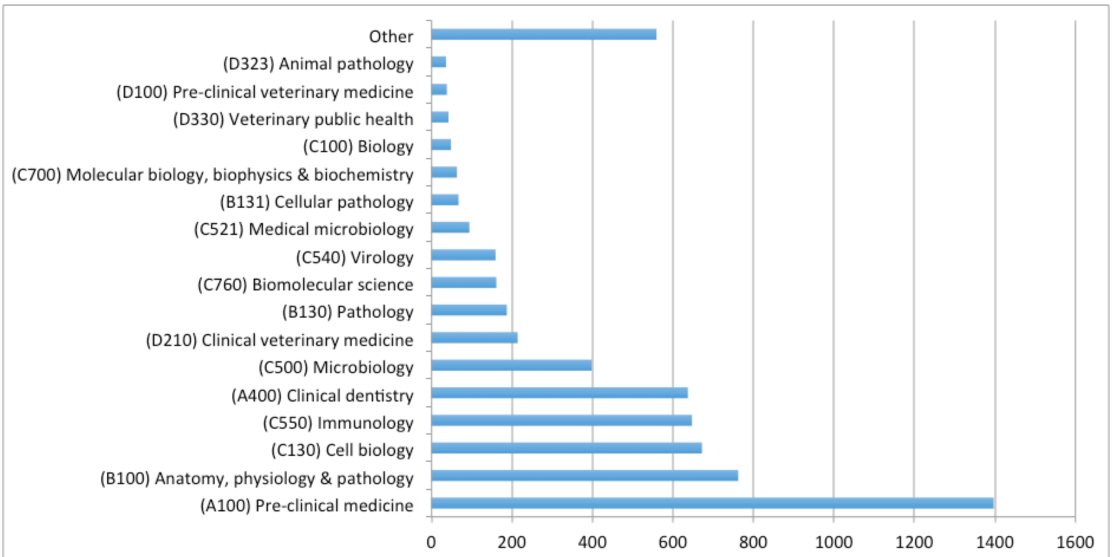


Figure 12b – Numbers of academic staff working in selected Current Academic Disciplines, excluding clinical medicine (CAD1; n=6180)

6.3 Analysis of the Academic Workforce in Immunology

6.3.1 Contract Level

The dataset contained 650 staff with immunology as their primary academic discipline (CAD1) and a further 140 with immunology as their secondary academic discipline (CAD2) – see figure 13. They were distributed across a range of contract levels (figure 13), including e.g. 9% at the level of Professor and 32% at the level of Senior Professional (Technical), Lecturer, Research Fellow, Researcher (senior research assistant) or Teaching Fellow.

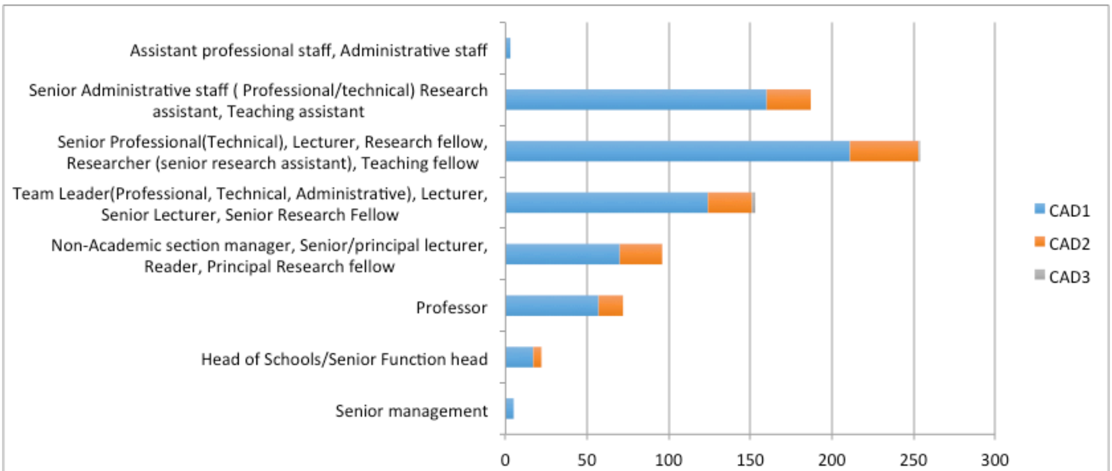


Figure 13 – Numbers of academic staff working in Immunology only by Contract Level (CAD1, 2 & 3; n=790)

6.3.2 Research and Teaching

68% of staff in immunology carried out research only (figure 14) and 30% conducted teaching alongside research.

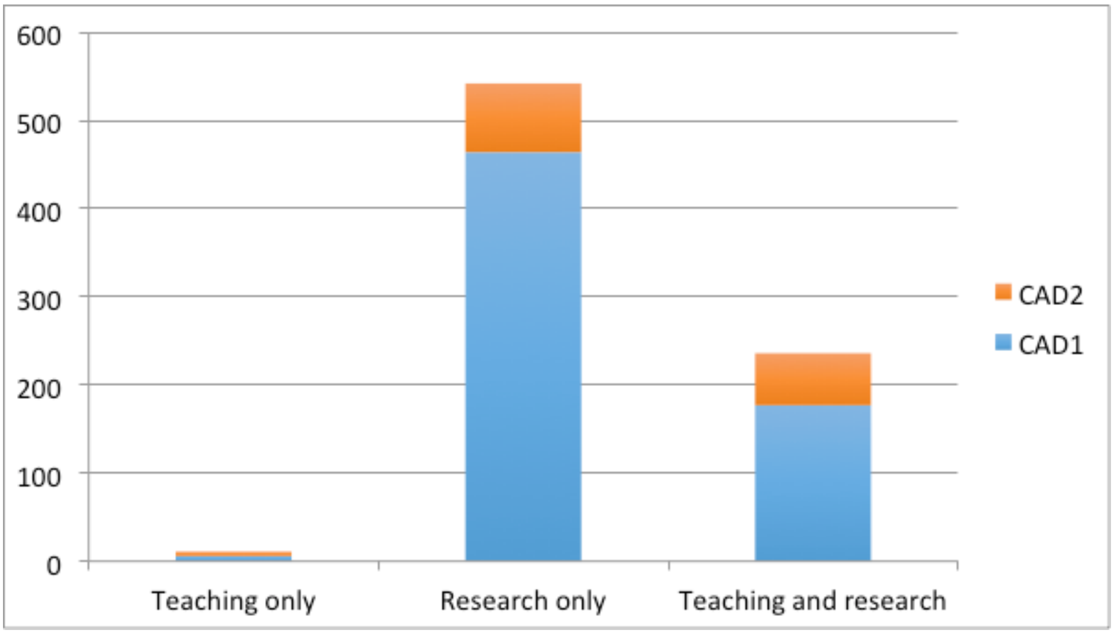


Figure 14 – Numbers of academic staff involved in research, teaching or both (CAD1 & 2; n=790)

6.3.3 Universities with the highest volume of immunology staff

31% of the immunology staff contained in the dataset were from the University of Oxford (figure 15). This diagram shows the universities with the highest numbers of staff classified as working in immunology. Notable absences are UCL and Imperial College London, for the reasons as described above (6.2.1).

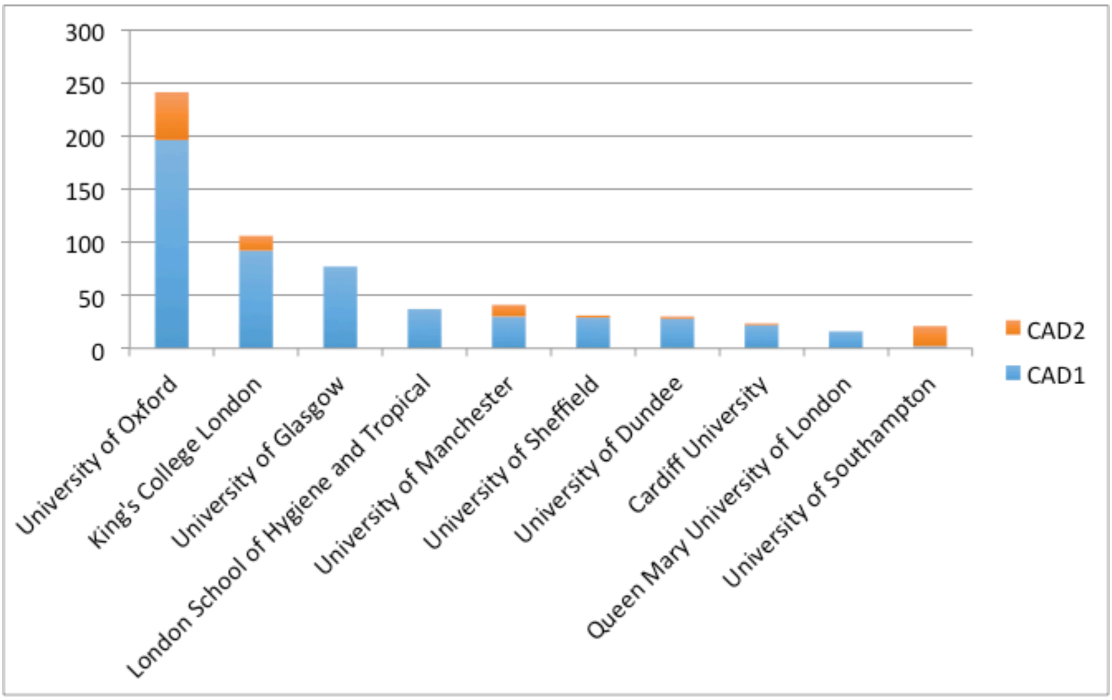
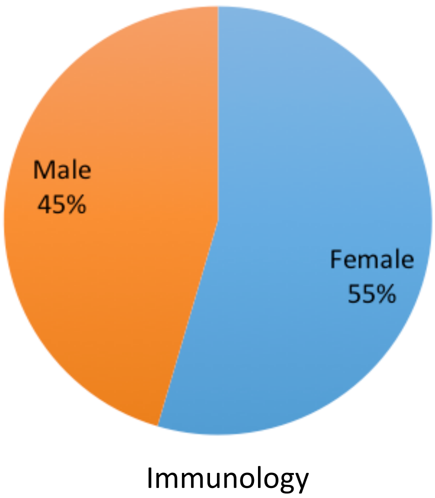


Figure 15 – Numbers of academic staff working in immunology (CAD1 & 2; n=625) at ten universities with the highest numbers of staff classified in immunology.

6.3.4 Gender

55% of staff with immunology as their primary subject were female (figure 16), compared with 51% for all selected subjects.



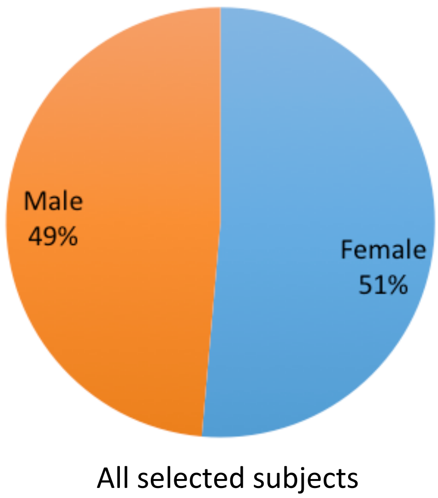


Figure 16 – Gender of academic staff working in immunology (CAD1; n=650) and all selected subjects (CAD1; n=13135).

When looking at gender by contract level (figure 17) it is apparent that less than 4% of females in immunology are at Professorial level compared to 15% for male immunologists. In contrast, a higher proportion of female immunologists have less senior roles at the levels of e.g. Research or Teaching Assistants, Lecturers or Research fellows.

Furthermore, there are also lower proportions of female immunologists in senior positions when compared to females working within other disciplines contained within this dataset.

Together, this data shows that whilst there are strong numbers of women working in immunology, they are less likely to attain senior positions than in many other disciplines within the selected fields of medical sciences.

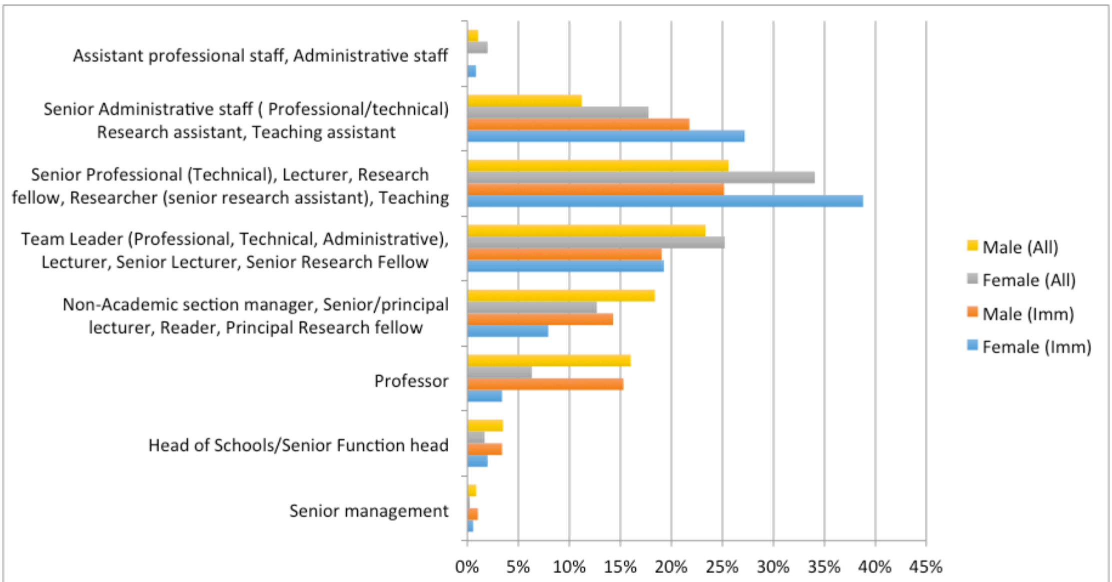


Figure 17 – Proportion of academic staff within each contract level by gender, working in immunology (CAD1) and all selected subjects (CAD1).

Further analysis of the data in figure 17 reveals that only 23% of immunologists (male and female) are in senior positions (senior lecturer or higher) compared with 30% of staff from all other disciplines selected.

6.3.5 Nationality

The nationalities of individuals working in immunology was explored and compared with other subjects (figure 18). 58% of immunology staff were from the UK and 26% were from another EU country. Subjects such as Clinical Medicine, Pre-Clinical Medicine, Anatomy, Physiology & Pathology, Dentistry and Microbiology all had higher proportions of staff from the UK than for immunology. Immunology attracts a higher proportion of staff from outside the UK than many other disciplines. This figure should be monitored in future years to assess the effects of the UK's departure from the European Union.

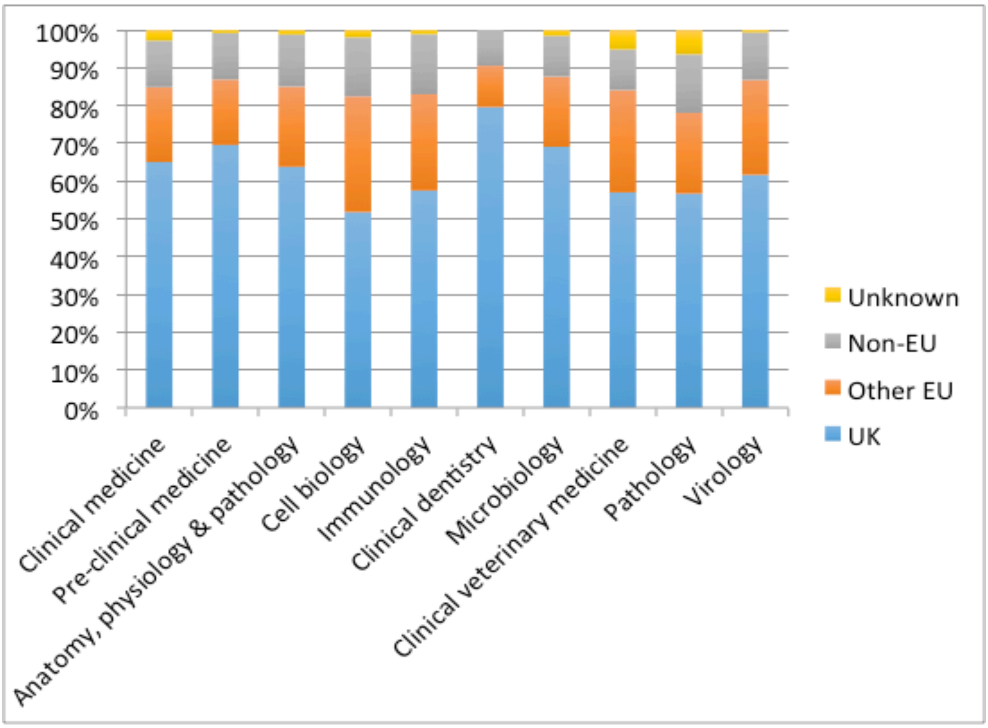


Figure 18 – The nationalities of academic staff working within a range of academic disciplines (CAD1; n=12030).

6.3.6 Source of basic salary

When comparing with across subject areas in the dataset, a higher proportion of immunology staff received funding from the MRC, Wellcome Trust, other charitable foundations and EU government (figure 19). In contrast, fewer immunologists were likely to receive their basic salary directly from the Higher Education provider.

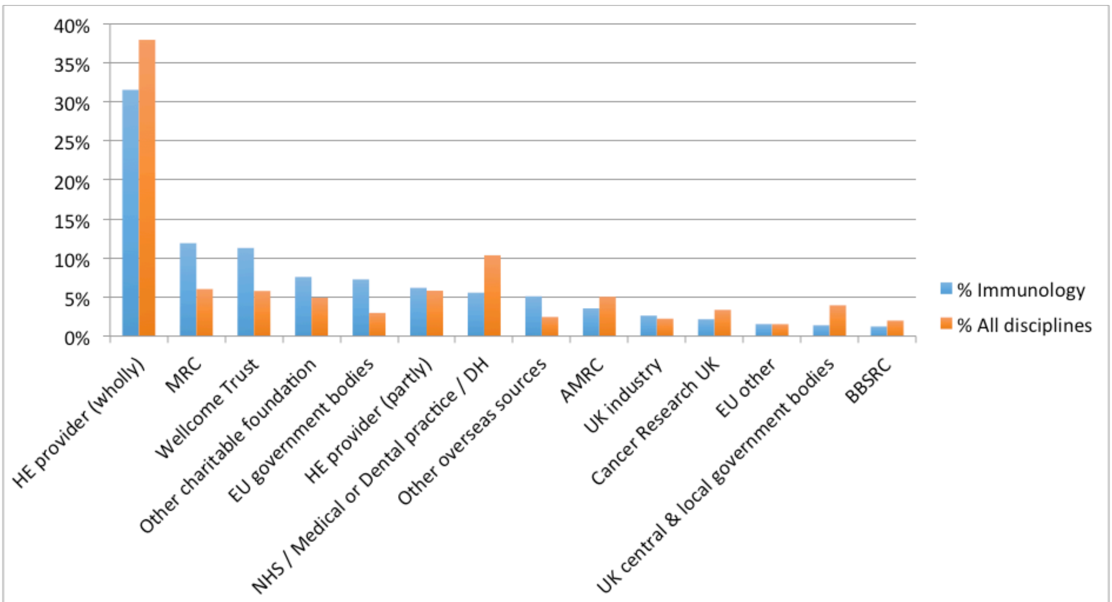


Figure 19 – The source of basic salary for academic staff working within immunology compared with all academic disciplines (including immunology) in the dataset (CAD1) – see Appendix 1 for subjects included.

When adding up these figures, almost half (47%) of immunologists in academia received funding from a medical research charity, Research Council or EU, a much higher proportion when compared to academics from across all disciplines in the dataset (32%).

Together with the results looking at contract level (figure 17), these results demonstrate that a higher proportion of staff working in immunology are in less senior positions and therefore more likely to receive their basic salary from grant funding than from the University.

7 Acknowledgements

We are grateful to the British Library for providing the data describing doctoral theses completed on topics related to immunology from their E-thesis online service (EThOS) database.

We are also grateful to Beth McKendrick, an intern working at the British Society for Immunology (BSI) and to Glyn Jones, Education and Careers Officer at the BSI for conducting part of the thesis author tracking.

The data for conducting the analysis of the academic workforce was provided under agreement from the Higher Education Statistics Agency (HESA). Neither the Higher Education Statistics Agency Limited nor HESA Services Limited can accept responsibility for any inferences or conclusions derived by third parties from data or other information supplied by HESA Services.

Dr Norman Freshney
May 2017

Appendix 1 – Data input and output parameters for the academic workforce search

Search Parameters (input):	*Description and notes*
Current academic discipline (subject in which the staff member is currently working):	
A100 – Pre-clinical medicine	Vocational science of preventing, diagnosing, alleviating or curing disease in homo sapiens. Includes such areas as Anatomy, Physiology, Pharmacy and Nutrition, which can be specialisms in their own right.
A300 – Clinical Medicine	The observation, diagnosis and treatment of an illness or disease through direct interaction with human patients.
A400 – Clinical Dentistry	The observation, diagnosis and treatment of disease or damage to teeth and gums through direct interaction with human patients.
B100 – Anatomy, physiology & pathology	The study of the human body and how it is affected by disease. Includes study at cellular and molecular levels.
B130 – Pathology	The study of the nature, causes and development of human diseases, and the mechanisms of disease infestation and transfer.
B131 – Cellular Pathology	The study of the effects and nature of diseases in cellular structures.
B132 – Pathobiology	The study of the biological nature of diseases.
C130 – Cell Biology	Concerned with the organisation of the cell, cell membrane and cell communication.
C500 – Microbiology	The scientific study of micro-organisms encompassing major components of genetics and molecular biology. Includes bacteriology, virology, cell structure and function, and may include some immunology.
C520 – Medical & veterinary microbiology	The study of the interactions between micro-organisms and their hosts.
C521 – Medical microbiology	The study of the interactions between micro-organism and their human hosts.
C522 – Veterinary microbiology	The study of the interactions between micro-organisms and their animal hosts.
C540 – Virology	The study of viruses and viral diseases.
C550 – Immunology	The study of the immune system as a defence mechanism against infection.
C570 – Serology	The study of sera and blood-related products.
C760 – Biomolecular science	The study of the molecular processes in the life sciences.
D100 – Pre-clinical veterinary medicine	Vocational science concerned with the diagnosis and treatment of disease in animals.

D210 – Clinical veterinary medicine	The observation, diagnosis and treatment of illness, disease or damage through direct interaction with non-human patients.
D320 – Animal Health	The study of animal diseases with the object of prevention or diagnosis and cure.
D323 – Animal pathology	The study of the effect of disease and/or damage to the animal frame. Studies include dissection and use of microscope slides.
D330 – Veterinary public health	The study of the prevention of the spread of disease from animals to man.

Table 1.1 – Input search parameters for data extraction from the HESA database (2015/16 only)

The parameters for the output data are described in table 3.

Data extraction categories (output):	*Description and notes*
Contract level:	
D and E	Head of Schools/Senior Function head
F1	Professor
F2	Function head
I0	Non-Academic section manager, Senior/principal lecturer, Reader, Principal Research fellow
J0	Team Leader (Professional, Technical, Administrative), Lecturer, Senior Lecturer, Senior Research Fellow
K0	Senior Professional (Technical), Lecturer, Research fellow, Researcher (senior research assistant), Teaching fellow
L0	Senior Administrative staff (Professional/technical), Research assistant, Teaching assistant
Academic employment function	Research only; Teaching only; Research and Teaching
Higher Education provider	Name of university
Source of basic salary	Funder (e.g. HEFCE, NHS, charity)
Highest qualification held	The highest qualification held by the member of staff
Sex	Male / Female
Nationality	UK/Other EU/Non-EU/Unknown
NHS Contract	

Table 1.2 – Output data parameters for data extraction from the HESA database (2015/16 only)

Appendix 2 – Current destinations of PhD graduates

Country	*No.*	*%*		*Country*	*No.*	*%*
UK	428	66%		Portugal	2	0.3%
USA	67	10%		South Africa	2	0.3%
Australia	10	1.5%		Argentina	1	0.2%
Canada	10	1.5%		Bangladesh	1	0.2%
Germany	10	1.5%		Belgium	1	0.2%
Singapore	7	1.1%		Botswana	1	0.2%
Ireland	6	0.9%		Cambodia	1	0.2%
Italy	6	0.9%		Colombia	1	0.2%
Taiwan	6	0.9%		Costa Rica	1	0.2%
India	5	0.8%		Cyprus	1	0.2%
Malaysia	5	0.8%		Egypt	1	0.2%
Saudi Arabia	5	0.8%		Eritrea	1	0.2%
Spain	5	0.8%		Estonia	1	0.2%
Denmark	4	0.6%		Indonesia	1	0.2%
Greece	4	0.6%		Iraqi Kurdistan (northern Iraq)	1	0.2%
Pakistan	4	0.6%		Israel	1	0.2%
Sweden	4	0.6%		Jordan	1	0.2%
China	3	0.5%		Libya	1	0.2%
France	3	0.5%		Mexico	1	0.2%
Ghana	3	0.5%		N. Ireland	1	0.2%
Kenya	3	0.5%		New Zealand	1	0.2%
Netherlands	3	0.5%		Oman	1	0.2%
Nigeria	3	0.5%		Romania	1	0.2%
Switzerland	3	0.5%		South Korea	1	0.2%
Thailand	3	0.5%		Turkey	1	0.2%
Austria	2	0.3%		USA / Uganda	1	0.2%
Brazil	2	0.3%		Yemen	1	0.2%
Iran	2	0.3%		Zambia	1	0.2%
Japan	2	0.3%		Zimbabwe	1	0.2%
Kuwait	2	0.3%				

Table 2.1 – Current destinations of PhD graduates in the dataset (n=651); see section 5.2.2