MRC Medical Research Council

Economic Impact Report | 2014-15

ISBN 978-0-903730-21-1

When providing a citation for this document we recommend the following:

Medical Research Council (2016) *MRC Economic Impact Report 2014/15.*
Publisher: Medical Research Council, Swindon, UK.
ISBN: 978-0-903730-21-1

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This publication is available at http://www.mrc.ac.uk/publications/browse/economic-impact-report-2014-15/

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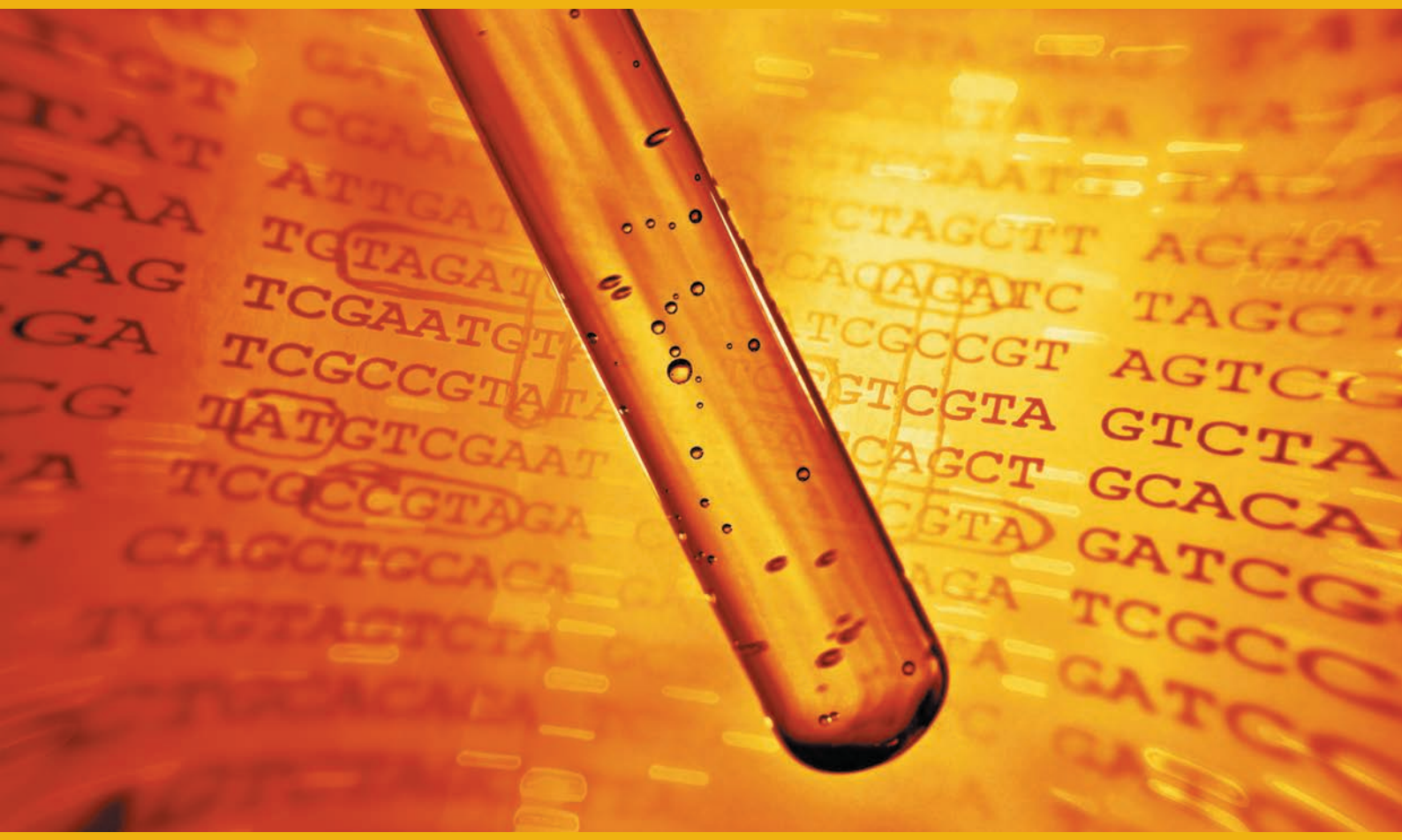
Introduction | 1.0



1.0 Introduction

The MRC Economic Impact Report has been published each year since 2005 and is part of the research councils' performance management framework implemented by the Department for Business, Innovation and Skills (BIS). All of the MRC's Economic Impact reports are available on the MRC website[1].

The research councils have worked closely with BIS to streamline the metrics that are presented in this report. The aim has also been to make reporting across the councils more consistent and to provide more informative and robust metrics. With all research councils now aligned to a common platform and framework for collection via researchfish®[2], this process will become more feasible in the future.

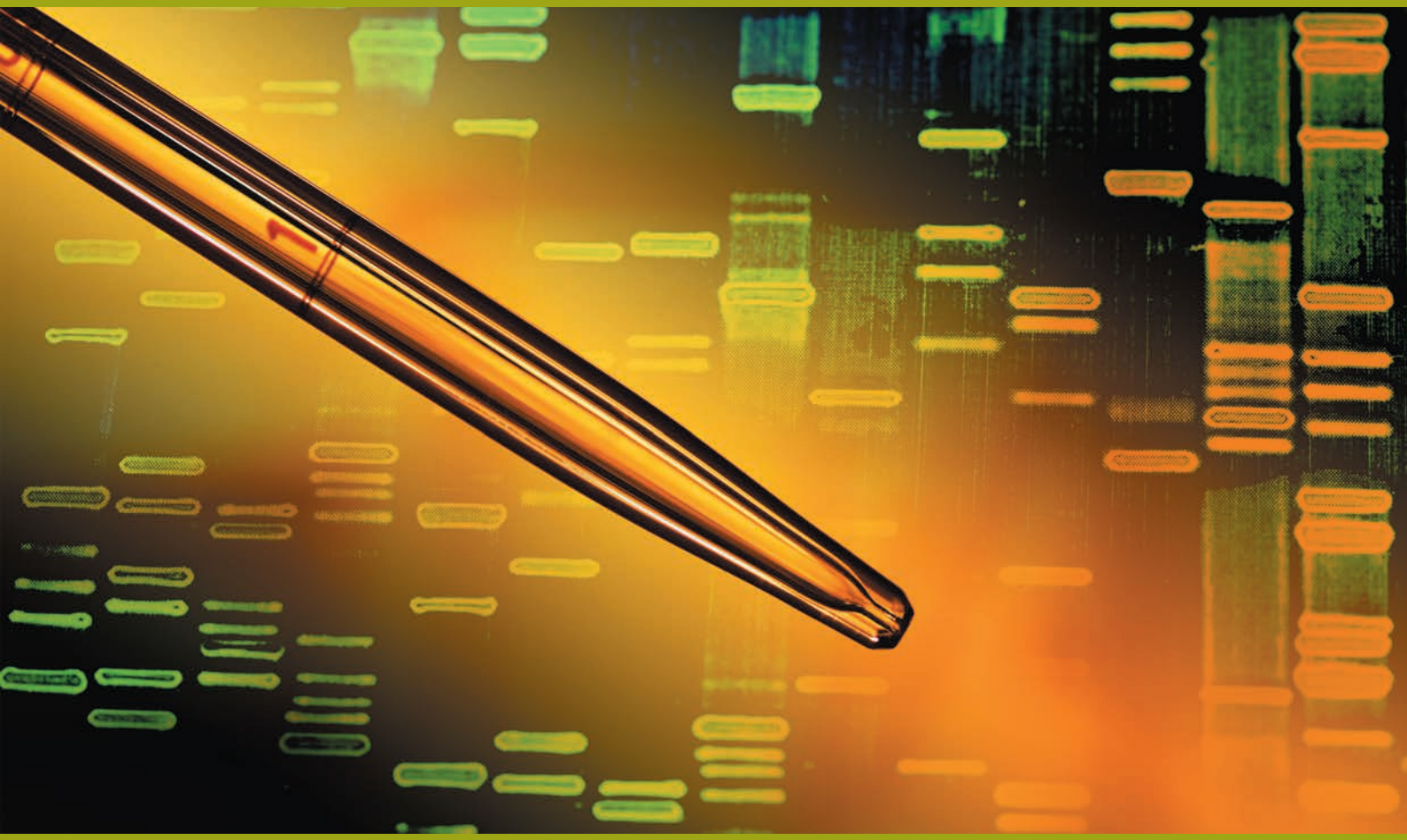
The list of metrics currently agreed between BIS and the research councils can be found in Annex 1, and supporting data is presented in Annex 2. Each research council also presents a small number of additional metrics and narrative information to ensure the report reflects the full range of activities undertaken by the council. The additional metrics for the MRC are noted in Annex 1. The MRC Economic Impact Report includes data covering the last five years, with some data extended further back where available.

In addition to the raw metric data, this report also includes further details on the inputs, outputs and outcomes required, including some example case studies. Further information on each study can be found on the Research Councils UK (RCUK)'s information portal— the Gateway to Research[3] — by entering the project reference number listed under each case study in the search field or following the link provided.

It is important to note that the data and case studies featured in this report represent only a small proportion of the data collected annually by MRC. More details and further case studies can be found in other MRC publications, in particular the *MRC Annual Report and Accounts 2014/15*[4] and the *Outputs, Outcomes and Impact Report 2014/15*[5]. All MRC publications can be found on the MRC website.

researchfish®
capture • evidence • share • inform

Summary and highlights | 2.0



2.0 Summary and highlights

The MRC is a publically-funded organisation dedicated to improving human health through world-class medical research. Established in 1913 and incorporated by Royal Charter in 1920, the MRC's mission is to:

- Encourage and support research to improve human health.
- Produce skilled researchers.
- Advance and disseminate knowledge and technology to improve the quality of life and economic competitiveness of the UK.
- Promote dialogue with the public about medical research.

To address this mission the MRC has developed, in consultation with the public, policy makers and the scientific community, a long-term strategic plan. In 2013 we published a refreshed strategic plan, *Research Changes Lives 2014-2019*[6], which continues our strategic direction, building on our strengths and achievements and also taking into account new scientific opportunities to secure tangible impact from MRC research.

The MRC has four key strategic aims:

- Picking Research that Delivers
  Setting research priorities which are most likely to deliver improved health outcomes.
- Research to People
  Bringing the benefits of excellent research to all sections of society.
- Going Global
  Accelerating progress in international health research.
- Supporting Scientists
  Sustaining a robust and flourishing environment for world-class medical research.

On the basis of this strategy the MRC has, through successive Government spending reviews, secured funding for medical research from the Department for Business Innovation and Skills (BIS). The *MRC Delivery Plan 2011/12-2014/15*[7] sets out in detail how these resources will be used to progress the MRC's strategy and support Government objectives for the science budget. The latest Delivery Plan for 2015/16 was released in 2014[8].

The MRC regularly monitors, evaluates and reports on successes and the outcomes, outputs and impact of the research support. The Economic Impact Reporting Framework is one part of this performance management process, alongside other MRC publications including our delivery plan reporting framework document[9], Annual Report[10] and Outputs, Outcomes and Impact of MRC Research series[11].

To better understand how MRC research leads to economic, societal and academic impact, all MRC-funded researchers are required to provide feedback on the impact of their work via an online system called researchfish®. These data are supplemented with additional analyses from other sources, such as bibliometric data. Combined, these datasets provide a detailed picture of the progress, productivity and quality of the science we support. This includes developing new medicines and technologies,

improving clinical policies and practices, and encouraging inward investment to the UK. A summary of the major findings in this report are detailed below.

MRC research is generating world-leading knowledge and skilled researchers

Since 2006 MRC-funded research has contributed to more than 94,000 publications. These include 63,000 scientific papers with more than 8,000 being reported in 2014 alone. Papers generated from MRC-funded research are also recognised as outstanding based on the leading bibliometric indicators. The average normalised citation impact (NCI)[12] of MRC papers is consistently twice the world average and double the proportion of MRC papers are in the top 10 per cent of cited works when compared to other UK clinical and biomedical science research. More than half of all MRC researchers report external recognition for their work (17,000 instances) including prizes, prestigious lectures and other awards. Furthermore, the MRC supports almost 1,500 PhD studentships[13] to encourage the next generation of researchers to maintain the UK's position as a centre of research excellence. Of these students, more than half will be in research-related employment six months post-PhD.

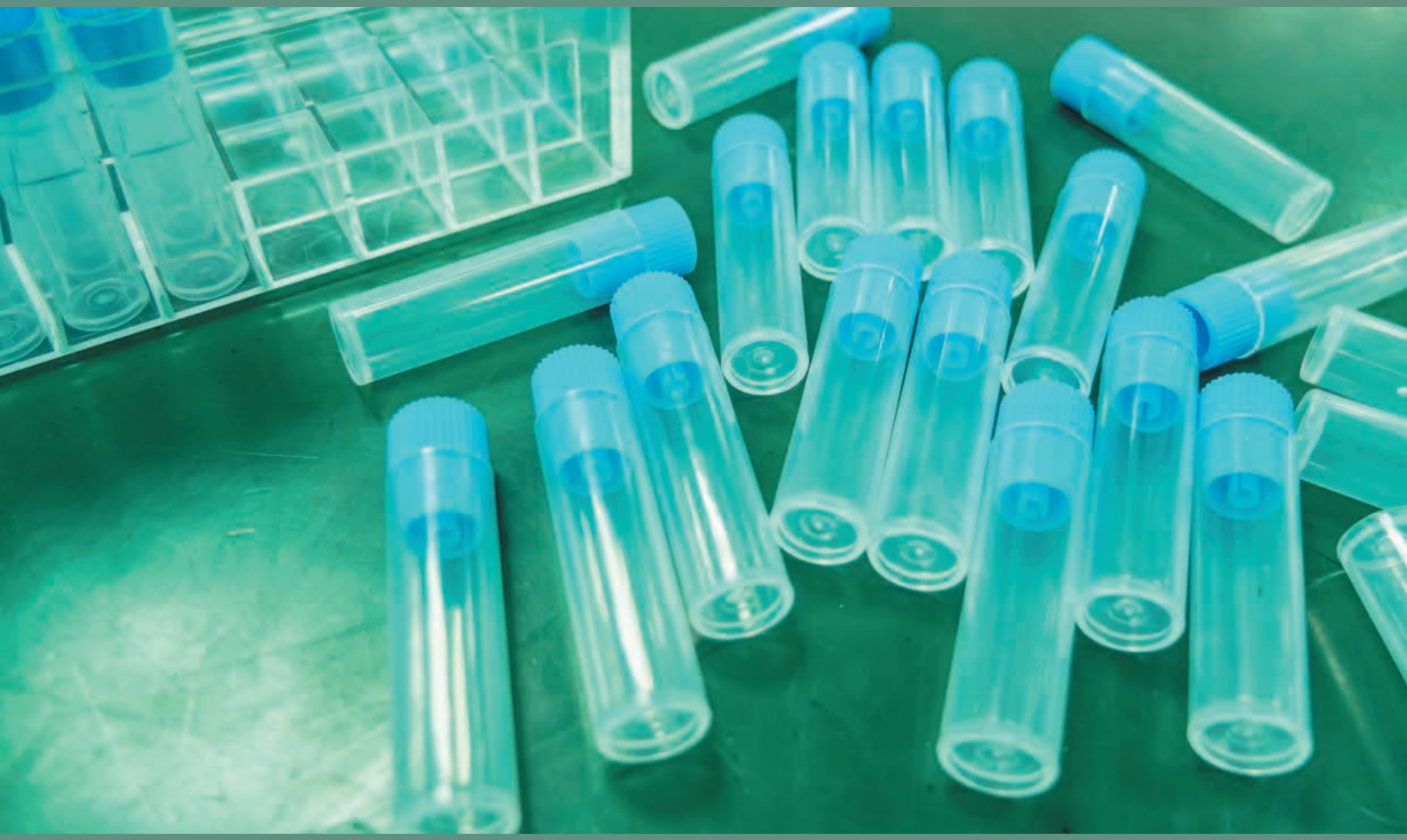
MRC research is highly collaborative and catalyses significant inward investment to the UK

Approximately 30 per cent of MRC research awards reported details of their collaborations. More than 15,000 unique partners have been reported since 2006, with an average of more than five partners per collaboration. Two thirds of collaborations are within academia, while more than a quarter of collaborations are with public sector, private sector or hospital partners. Almost half of all MRC awards lead to additional research funding, with more than £4bn of further funding accumulated by MRC researchers in the past eight years. Details from MRC research papers show that 50 per cent benefit from international collaborations.

MRC translational research is bringing new treatments to the clinic and providing a rich pipeline of opportunities for commercialisation

MRC-funded researchers have reported more than 1,000 products and interventions in development and the creation of more than 5,600 new research materials since 2006. Novel discoveries have led to more than 1,000 intellectual property claims and 88 spin-out companies have been formed partly as a result of MRC research. The MRC has also awarded more than £325m in funding knowledge exchange programmes since 2008/09— £62.6m in 2014/15 — to encourage greater translation of basic scientific discoveries into effective treatments. Approximately 150 products realised via MRC-funded research have reached the lattermost stages of market authorisation/adoption. More than 4,400 instances of policy influence have been reported since 2006, highlighting the active role MRC-funded researchers take in setting public policy and the importance of MRC research findings to evidence-based policy-setting.

Inputs: investment in the research base | 3.0



3.0 Inputs: investment in the research base

3.1 Income and expenditure

In 2014/15 the MRC's gross research expenditure was £771.8m compared to £845.3m in 2013/14[14] and £766.9m in 2012/13. The support for world-class medical research to improve human health and enhance the economic competitiveness of the UK included:

- £366.7m on grants and to researchers in universities, medical schools and research institutes.
- £240.3m on programmes within the MRC's own units and institutes, including £7.2m on studentships.
- £84.2m on programmes within university units.
- £63.9m on studentships and fellowships in universities, medical schools and research institutes, supporting 1,488 students, 154 clinical research training fellows and 237 research fellows[15].
- £16.6m for international subscriptions.

Further details on income and expenditure can be found in Annex 2 (Section 3.1) and in the *MRC Annual Report*[16], pages 95 to 104.

3.2 Human capital (input)

The MRC's vision for training and careers is to train and develop the next generation of research leaders. The MRC aims to strengthen and sustain a world-leading medical research workforce equipped with contemporary skills across a range of basic science and clinical disciplines by:

- Supporting excellent individuals at critical points of their careers through continued investment in clinical and non-clinical research training to ensure a demanding and rewarding research experience at each career stage.
- Investing in areas with the most potential to deliver excellence and innovation for human health, with particular attention to national strategic research skills needs.
- Enhancing the development, support and career options for non-traditional highly-skilled technical researchers.
- Increasing support and skills development for research leaders of tomorrow including mentorship.

Supporting fellows and students in universities

The MRC funds a range of fellowship award schemes for both clinical and non-clinical researchers, as well as specific fellowships schemes targeting strategically important research areas or skill-sets. There is further information on MRC schemes on our website[17] as well as comments from researchers showing how the MRC has supported them through their careers.

The capacity and skills spend for the financial year 2014/15 was £71.1m; £7.2m within MRC units and institutes and £63.9m within universities, medical schools and research institutes. A total of £28.5m supports studentships while £42.6m supports fellowships (including Clinical Research Training Fellowships[18]).

Supporting staff in MRC institutes and units

As at March 2015, the MRC directly supports 1,904 research staff in intramural MRC institutes and units; 1,153 Principal Investigators (61 per cent), 357 Research Leaders in sponsored institutes (19 per cent) and 394 research fellows (21 per cent).

Outputs: research performance | 4.0

4.0 Outputs: research performance

Introduction: researchfish® and the use of outputs, outcomes and impact data

The majority of data on the MRC's outputs and outcomes featured in this report are collected through researchfish® (previously MRC eVal)[19]. This is a federated system used to capture information on outputs, outcomes and impacts from MRC-funded researchers. researchfish® is now used by more than 100 research/funding organisations[20] including, as at September 2014, all UK research councils.

Researchers can enter, amend and update information in researchfish® all year round, but the MRC requires researchers to submit a return in the system once a year[21] for the lifetime of the award and a number of years beyond. This means that numbers reported this year will be different to those reported previously as researchers can continue to add information retrospectively to provide a fuller account of research progress. The researchfish® data-gathering period for 2013/14 closed in November 2014, thus numbers for 2014 are incomplete. Therefore in the subsequent sections of this report a projected total for 2014 has been estimated, where applicable.

It is also important to note that there will some variations in analysis between reporting periods, as the modifications to the researchfish® question sets, data processing/cleaning (de-duplication, disambiguation etc.) and changes in coding practice will affect some data outputs. Therefore, while data presented here may be found in other researchfish® reports[22] and MRC publications[23], there may be some slight differences in the figures reported.

The latest reporting year (2014) was the seventh year that researchers used the system, and 94 per cent of the MRC scientists who had held any funding from the organisation since 2006 submitted information relating to over more than 5,000 awards in total (5,086 responses from an expected 5,416).

It is important to note that while counts of researchfish® data help illustrate the volume of output information collected, the MRC is primarily interested in the quality of outputs received. We are most interested in how MRC research contributes to the development of new medicines and technologies, improvements to clinical and public health policies and practices, and how it encourages inward investment to the UK. Therefore outputs reports are extensively reviewed to identify duplicates and to consider whether they meet basic criteria such as being evidenced, justifiably linked to a core MRC programme and occur within the relevant timescale[24]. The main exception to these internal duplication checks are published outputs. The primary aim with publications is to benchmark outputs using a variety of more quantitative bibliometric approaches such as citation indexing.

Finally, while researchfish® data is used for the majority of outputs within this report, MRC collects data from additional sources to provide further information on our activities. These include bibliometric data from Thompson-Reuters, studentship information from the Joint Electronic Submission (JeS) service and Higher Education Statistics Agency (HESA) and internal MRC grant/financial systems.

Impact summary

MRC-funded research funded between 2006 and 2014 has contributed to:

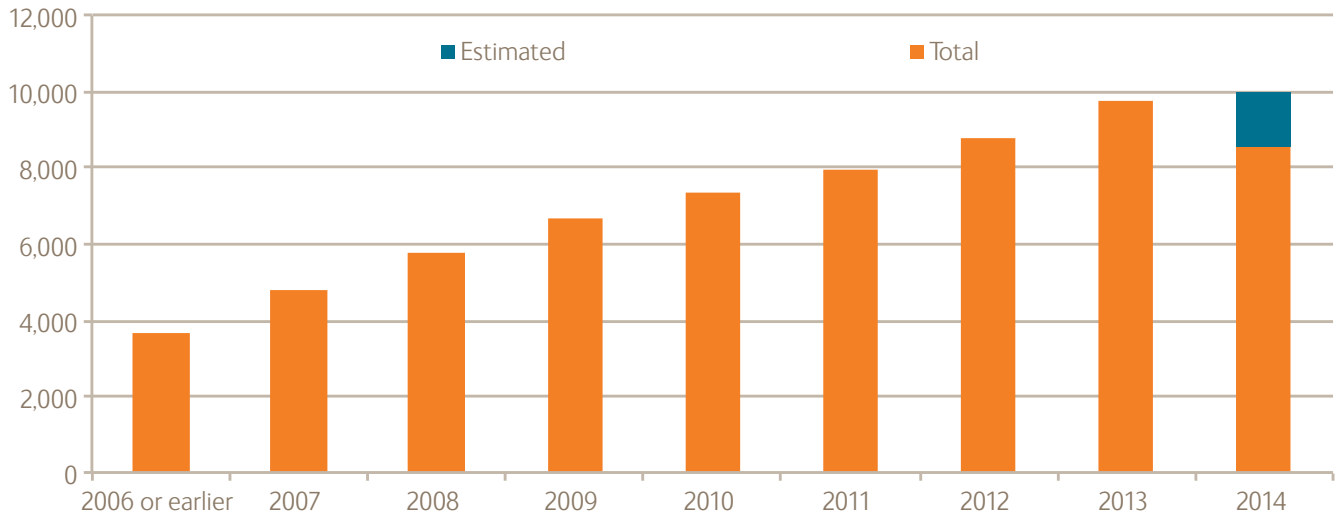
- More than 63,000 scientific papers (8,590 new in 2014) with more than twice the world citation impact on average.
- The development of more than 4,400 instances of influence on policy and practice (416 new in 2014), including 472 citations in clinical guidelines.
- The development of more than 1,000 products and interventions (126 new in 2014).
- The creation or growth of 88 companies (seven new in 2014).
- Approximately 1,081 patents (37 filed or granted in 2014), with discoveries related to 246 (23 per cent) of these patents already licensed worldwide.
- More than 15,400 instances of collaboration with researchers in more than 100 countries.

4.1 Knowledge generation

4.1.1 Publication outputs

Publications are an important primary output from research and an important part of the scientific method. They record new knowledge, methods or insights from existing work and enable these to be used in other research. Figure 1 shows the number of unique publications reported in researchfish® arising from MRC-funded research by year of publication. Since 2006, MRC-funded research has generated more than 94,000 publications, of which more than 63,000 are peer-reviewed scientific publications (see Annex 2 Section 4.1 (metric 8) for specific figures).

***Figure 1**: Numbers of unique publications submitted by MRC-funded researchers via researchfish® by year of publication*



The citation of publications in further peer-reviewed research articles is often used as a measure of quality. These citation counts can be normalised by scientific field and year of publication to give a measure of "normalised citation impact" (NCI). An NCI score of 1 means that the paper is behaving as would be expected for that subject area in that year, and this is referred to as the world average. Therefore an NCI of above 1 means that the paper is cited more often than would be expected and is above the

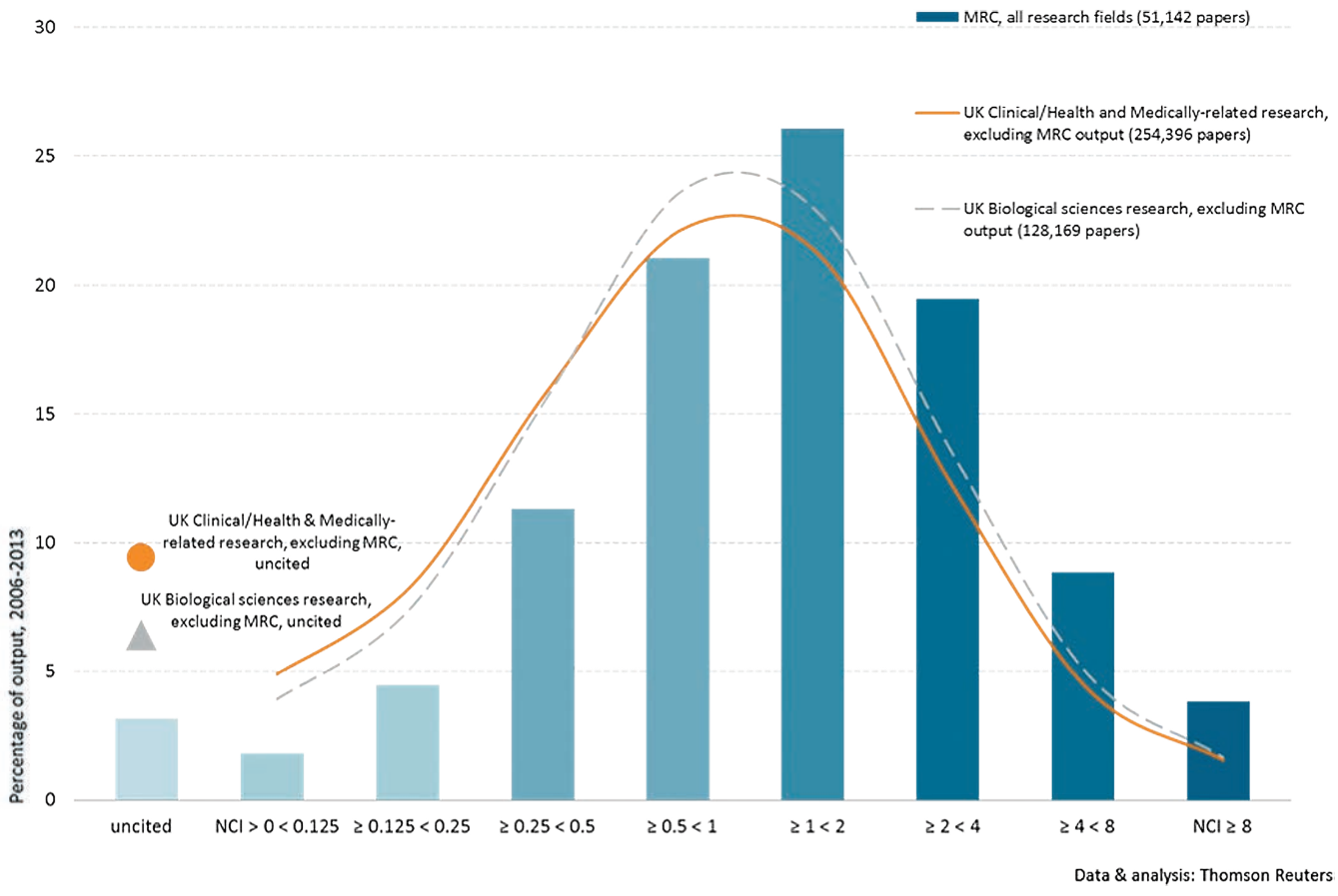
world average. Further bibliometric measures include the number or percentage of articles that are either uncited or, conversely, those deemed as 'highly cited' (ie NCI≥4) and 'very highly cited' (ie NCI≥8)[25]. The distribution of MRC-funded paper citations are displayed in Figure 2.

The average normalised citation impact for MRC publications from 2006 to 2013 is 2.08, more than twice the world average[26].

Of the global total of more than six million papers, more than a fifth (21 per cent) have not been cited. Within the UK biomedical field this falls to between six and 10 per cent but MRC-funded research has only three per cent of papers gaining no citations to date.

MRC-funded research generates a greater percentage of highly-cited papers than other UK clinical and UK biological sciences research (12.7 per cent compared to 5.8 per cent and 6.5 per cent respectively). It also generates a greater percentage of 'very highly-cited' papers (NCI≥8) than UK clinical and UK biological sciences research (3.8 per cent compared to 1.6 per cent and 1.7 per cent respectively).

Figure 2: *Impact Profile® of citation scores for MRC publications in comparison to UK clinical and biological science research output.*



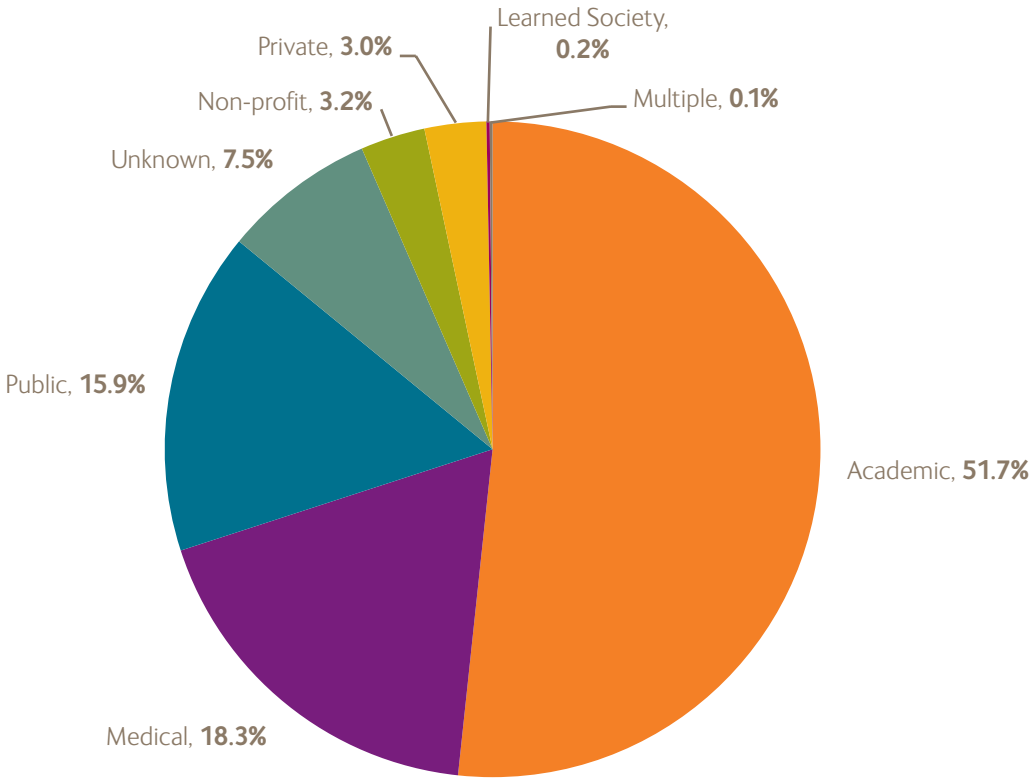
Co-authorship

Analysis of the authors who have contributed to a research publication can be used as an indicator of collaborative working, and are particularly useful as indicators for international relationships between researchers. Analysis of these MRC-attributed papers in researchfish® shows that 50 per cent have at least one author from outside the UK.

As with research collaborations, the co-authorship of research publications can be indicative not just of the number of researchers involved but also of the complexity of the work and the level of interdisciplinarity of the research being conducted. Such cross disciplinary connections can not only increase the distribution of research findings, but can in turn improve coordination of research funding across different research networks.

Figure 3 shows the co-authorship by sector of all MRC-funded papers reported in researchfish®.

Figure 3: *Co-authorship of all MRC-funded papers 2006 to 2014 by sector*



Papers published in 2014 already exhibiting high citation impact

In the bibliometric analysis, we included papers entered into the Thompson-Reuters database between the years 2006 and 2013 with citation counts taken at the end of 2014. This means that all papers have had at least one year to accumulate citations. There are papers, however, published at the end of 2013 and during 2014 that have already rapidly been cited.

The following case studies are adapted from published articles already being cited at a rate that is more than 60 times the world average.

A molecular marker of artemisinin-resistant Plasmodium falciparum malaria

NCI:	DOI:	Article:
112	10.1038/nature12876	**Ariey** *et al.* **(2014)** *Nature* **505: 50–55**

This international study identified that a mutation in a region of the K13 gene was associated with artemisinin resistance in the malaria-causing parasite *Plasmodium falciparum.*

Artemisinin-based combination therapies (ACT) are recommended by WHO as the first-line treatment for uncomplicated *P. falciparum* malaria. Expanding access to ACTs in malaria-endemic countries has been integral to the recent success in reducing the global malaria burden.

However artemisinin resistance, defined as an increased parasite clearance half-life or microscopically-detectable parasites on the third day of ACT treatment, is a growing problem. Resistance had been confirmed in five countries in the Greater Mekong Subregion in South East Asia in February 2015, being worst along the Cambodia-Thailand border.

The researchers, including those at the **MRC Centre for Genomics and Global Health, University of Oxford**, used whole-genome sequencing of an artemisinin-resistant parasite line from Africa and clinical parasite isolates from Cambodia to identify the gene mutation and show its association with slow parasite clearance rates. This will be a useful molecular marker for large-scale surveillance efforts to contain artemisin-resistance in this South-East Asian region and prevent its global spread.

This study also benefited from funding by several other organisations and programmes, including the Global Fund Grant Malaria Program, the Bill and Melinda Gates Foundation and USAID, NIH and the Wellcome Trust.

MRC Grant Ref: G0600718

Association of dietary, circulating, and supplement fatty acids with coronary risk: a systematic review and meta-analysis

NCI:
85

DOI:
10.7326/M13-1788

Article:
Chowdhury *et al.* **(2014).** *Annals of internal medicine* **160(6): 398-406**

A meta-analysis conducted by researchers at the **MRC Epidemiology Unit** has found there to be no association between saturated fat intake and heart disease, despite views to the contrary.

The researchers combined the results of 72 studies that had examined the link between fatty acids and heart disease (including heart attacks, coronary heart disease and angina). They found no significant evidence that saturated fats increase the risk of heart disease and additionally, no significant evidence that omega-6 and omega-3 polyunsaturated fats protect the heart. However some of the studies had included people with risk factors for heart disease or who currently had heart disease, so the results might not apply to the population as a whole. Despite this, the researchers highlight that further research is needed, particularly in people who are initially healthy.

The lack of association was seen in studies that looked at dietary intake, circulating levels in the blood and in randomised trials that had looked at supplementation effects.

The study was also funded by the British Heart Foundation, Cambridge National Institute for Health Research Biomedical Research Centre, and Gates Cambridge.

MRC Grant Ref: MR/K026585/1 & MC_UP_A100_1003

Non-paper outputs

The following outputs, outcomes and impacts that have arisen either wholly or partially from MRC-funded research were all reported through researchfish®.

The data and analysis in this report represents only a small part of what the MRC does with the information collected through researchfish®. Further analysis and stories of impact can be found in the researchfish® reports[27], in many other MRC reports and on the MRC website.

4.1.2 Collaborations

Collaborative work is of increasing importance in helping the MRC deliver all strands of its mission to improve the health of the nation through world-class medical research. Collaboration has been shown to drive research excellence. In a period of constrained public finances it is even more important to have access to a wider range of facilities and equipment through a pooling of resources and expertise[28].

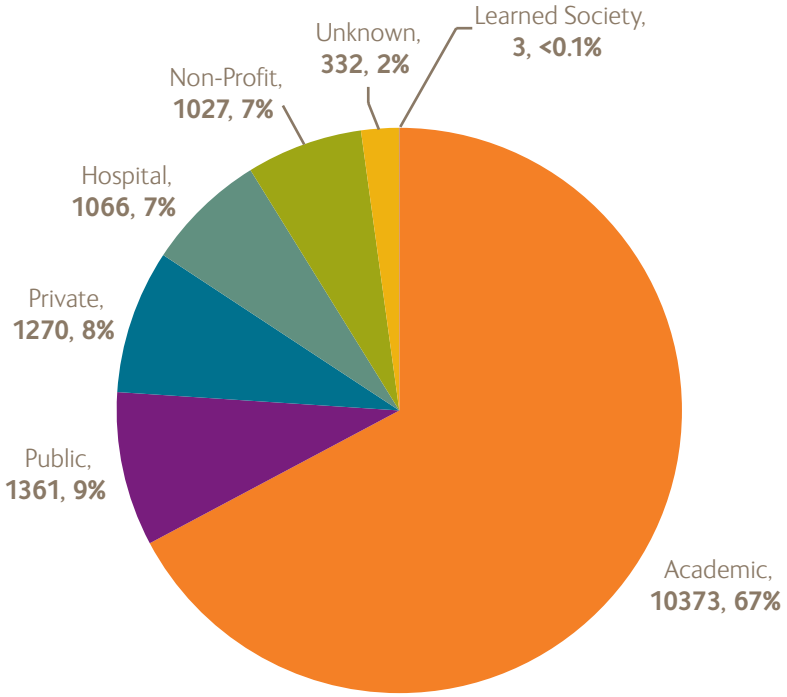
Recipients of 30 per cent of MRC awards reported that they had embarked on new collaborations as a result of their MRC-funded work. Each collaboration can include a number of partners across different sectors. These partners may be funded by multiple sectors (for example, charitable, public and private sources) and are not confined to just the UK. Researchers reported a variety of purposes for engaging in a collaboration, including funding, access to equipment, and provision of analytical techniques and expertise.

- Recipients of 37 per cent of awards (2,971) reported that they had been part of one or more collaboration(s) between since 2006.
- There were 15,432 collaborations reported (974 in 2014), involving a total of 14,118 unique partner organisations.
- The average number of collaborators linked to awards reporting at least one collaboration was six (5.86), a slight increase on last year's average (5.42).
- Six per cent (331) of awards were highly collaborative, reporting links to more than ten different collaborators.

researchfish® data allow us to examine how researchers are engaging with partners from different sectors. Most collaborations reported were with academia (67 per cent), followed by the public sector (nine per cent), the private sector (eight per cent) and hospitals (seven per cent).

Figure 4 shows the proportion of MRC collaborations by sector (see Annex 2 Section 4.1 (metric 11) for specific figures).

Figure 4: *Proportion of MRC collaborations from 2006 to 2014 by sector*



Examples of excellence through collaboration:

Professor Derek Mann at the **University of Newcastle** is working with GlaxoSmithKline (GSK) to develop drugs that can stop or even reverse liver fibrosis.

Chronic liver disease is currently the only common cause of death that is on the rise in the UK[29]. The number of deaths from the disease have increased 400 per cent since 1970 and, in people younger than 65 years, have risen by almost five times[30]. One of the main pathologies in liver disease is fibrosis; scarring of the liver due to cellular damage by viruses, bacteria, toxins or dietary factors including alcohol.

Professor Mann and his MRC-funded team had previously identified that a specialised cell in the diseased liver called the liver myofibroblast promoted scar formation, maintenance and spread[31]. Professor Mann was also part of an international study that confirmed that manipulating these myofibroblasts can stop and even reverse fibrosis[32].

The work with GSK aims to identify existing drugs or new compounds that target myofibroblasts to treat fibrosis. This research is also investigating epigenetic markers — changes that affect the expression or activity of genes without changing the underlying DNA sequence — to identify patients most at risk from developing fibrosis and who would best benefit from new therapies. The work has already contributed to an on-going clinical study and a pipeline of new molecular targets, some of which are in drug development at GSK.

The collaborative contract with GSK has been extended until the end of 2016 and increases the amount of GSK funding to £1.4m.

MRC Grant Ref: G0700890

Dr Lucy Okell, **Professor Azra Ghani** and colleagues at **Imperial College London** have collaborated with the Medicines for Malaria Venture (MMV)[33], a global private-public consortium aiming to discover and develop affordable antimalarial treatments, since 2012.

Malaria (*Plasmodium falciparum*) is a life-threatening parasitic disease transmitted to people through the bites of infected mosquitos[34]. It is prevalent in many tropical parts of the world, mostly in Africa, Asia and South America. It caused around 500,000 deaths in 2013, mostly in African children.

The MRC-funded Imperial College group are developing mathematical models and analysing disease data to better understand malaria burden, the impact of public health interventions and to inform malaria control policy. MMV awarded £317,000 to Dr Okell and Professor Ghani to assess the impact and cost-effectiveness of both existing antimalarial drugs and other drugs in development.

In the first part, the group assessed the benefits of two existing major drug regimens; artemether–lumefantrine (AL) and dihydroartemisinin–piperaquine (DHA–PQP). Clinical trial data had showed that DHA–PQP provided longer protection against reinfection, while AL was better at reducing patient infectiousness. Dr Okell combined data on the transmission-reducing effects and cost of these two drugs with location-specific information on transmission intensity, population density, treatment access and costs in a mathematical model simulating drug pharmacokinetics, malaria transmission and treatment[35].

Dr Okell found that DHA-PQP had a slightly higher estimated impact than AL in 64 per cent of the at risk population, but was a higher cost treatment. Therefore DHA-PQP has slightly greater cost per case prevented, except in areas with high seasonally varying transmission where the impact is particularly large. Dr Okell's research therefore suggests that tailoring the treatment policy to location would be cost-effective in reducing malaria burden.

MRC Grant Refs: G1002387 & MR/J012254/1

4.1.3 Medical products or interventions

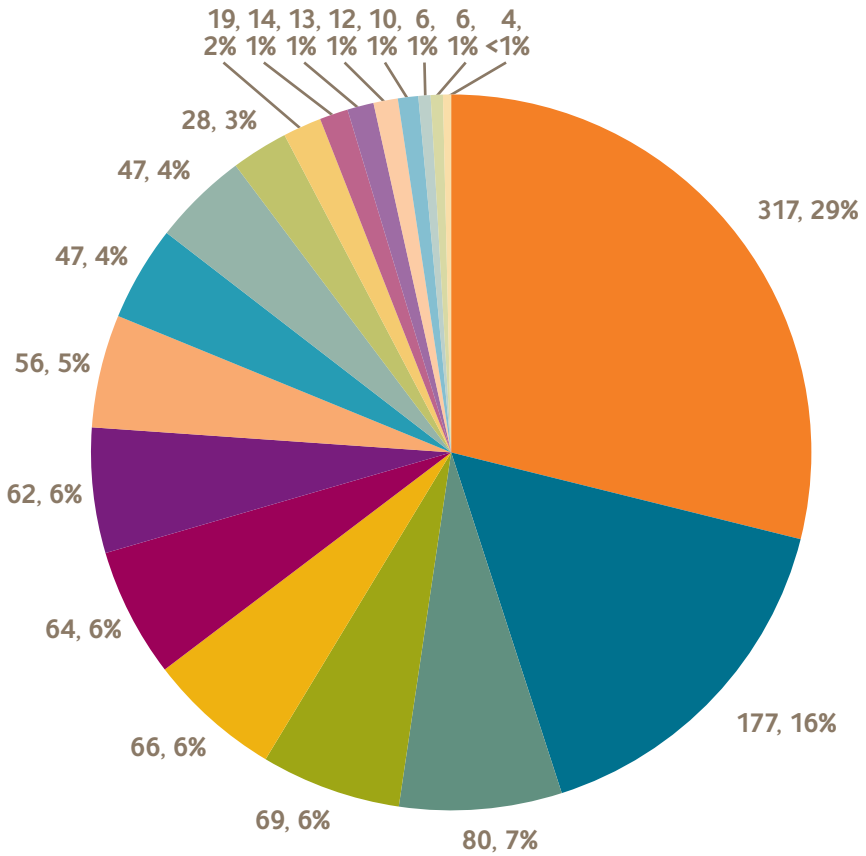
Medical products, interventions and clinical trials include the development of diagnostic tools such as screening, therapeutic interventions including drugs, vaccines, medical devices or surgery, preventive interventions and health/social care services. researchfish® also records the current stage of development that the product or intervention has reached. In 2014, two new categories of products were added to researchfish®; *Artistic and Creative Products* and *Research Software and Technical Products.*

Reports of *Medical Products, Interventions and Clinical Trials* in researchfish® detailing 1,097 product, intervention or trial realised between 2006 and 2014, from approximately 12 per cent of awards. The number of reported instances of *Artistic and Creative Products* and *Software and Technical Products* were 112 (from 68 awards) and 35 (from 16 awards), respectively. For more details on these non-medical products from MRC awards, please see the *MRC Outputs and Outcomes* report[36].

Medical products and interventions by type

Figure 5 shows the percentage of each type of product, intervention or trial reported between 2006 and 2014. The most common category of product or intervention in development was the "*therapeutic intervention – drug*", with 317 instances reported (29 per cent of all instances of products and interventions reported).

Figure 5: *Distribution of medical products or interventions reported between 2006 and 2014 by type*



Medical products and interventions by development stage

Between 2006 and 2014, MRC researchers reported 569 medical products in initial or refinement stages (52 per cent), 360 medical products and interventions in early- or late-stage clinical evaluation (33 per cent) and 167 medical products and interventions in approval for or already marketed (15 per cent). Table 1 below shows the distribution of numbers of medical products and interventions by development stage.

Table 1: *Distribution of medical products and interventions reported from 2006 to 2014 by development stage*

	Therapeutic Intervention	Diagnostic Tool	Support Tool	Preventative Intervention	Management of Diseases and Conditions	Products with applications outside of medicine	Health and Social Care Services	Total (%)
Initial development	158	79	54	20	28	3	3	**345 (31%)**
Refinement (non-clinical)	64	33	19	7	0	0	3	**126 (11%)**
Refinement (clinical)	59	25	8	2	4	0	0	**98 (9%)**
Early clinical assessment	150	43	9	22	8	0	0	**232 (21%)**
Late clinical evaluation	90	10	1	5	17	1	4	**128 (12%)**
Market authorisation	11	6	5	0	1	0	0	**23 (2%)**
Small-scale adoption	16	26	29	5	2	0	2	**80 (7%)**
Wide-scale adoption	17	21	11	5	8	2	0	**64 (6%)**
Total (%)	**568 (52%)**	**243 (22%)**	**136 (13%)**	**66 (6%)**	**69 (6%)**	**6 (1%)**	**12 (1%)**	**1,100 (100%)**

Specific examples of medical products in development:

Dr Christoffer Nellaker at the **MRC Functional Genomics Unit, University of Oxford** has developed facial recognition technology that could help diagnose rare genetic diseases.

Between 30-40 per cent of genetic disorders, including Down's syndrome and Marfan syndrome, involve changes to the face or skull. This is because many genes are involved when the face and head develop and so if there is a DNA change in one of these genes it is very likely that it will cause a change to the head or facial structure.

The new software is based on research involving thousands of pictures of previously diagnosed patients. It is able to 'learn' the facial features characterising each disorder and recognise which to look for and which to ignore when suggesting a diagnosis. It will also be able to group together patients with unknown disorders who have similar skull structures and facial features. This will potentially enable doctors to identify new disorders and the DNA variations that cause them.

The software is based on an algorithm that uses basic equipment and so could fairly easily be adapted for use in countries where genetic disease diagnosis is not readily accessible. It could help narrow down the tests needed to diagnose an individual, critical in healthcare systems where money is a factor in determining how many tests are carried out.

Dr Nellaker developed the software in collaboration with Professor Andrew Zisserman at the university's department of engineering science who was funded by the Engineering and Physical Sciences Research Council (EPSRC). The researchers are now taking this forward with an MRC Methodology Research Fellowship and a MRC Methodology Research Grant. Collaborations are being formed with clinicians around the world with the aim to bring this to patients as soon as possible.

MRC Grant Ref: MR/M014568/1

Dr Anthony Vugler at **University College London (UCL)** is working with ReNeuron[37], a UK-based stem cell company to develop a treatment for retinitis pigmentosa (RP), the leading cause of inherited vision loss.

RP refers to several genetic eye disorders that affect the retina, the part of the eye that receives and converts light energy into signals that are sent to the brain for visual recognition. The condition is caused by gene mutations causing degeneration of the retinal photoreceptor cells, resulting in a gradual, progressive reduction in vision and eventual, complete blindness. The condition affects around 1 in 3,000 to 4,000 people. Its onset ranges from infancy to mid-thirties and the rate of deterioration varies depending on the mutations involved[38,39].

Funded by the MRC's Biomedical Catalyst, Dr Vugler has conducted several pre-clinical studies to assess the effectiveness and safety of using human retinal progenitor cells (hRPCs), generated by ReNeuron, to treat RP. Progenitor cells are similar to stem cells in that they are undifferentiated. However, unlike stem cells, hRPCs have a limited capacity for self-renewal, and are often destined to become a particular cell type[40]. Dr Vugler has shown that when transplanted into the retina of rats with retinal degeneration, the hRPCs preserve existing photoreceptors and significantly slow vision loss. He has also shown that the hRPCs can safely integrate into the normal retina without damaging the host retinal structure and visual function. This means it may be possible to integrate these cells at comparatively early disease stages. These experiments also suggest that in addition to slowing vision loss in RP, hRPCs could also be used for the long-term, sustained delivery of therapeutics to treat other retinal diseases.

ReNeuron has received regulatory approval from the US Food and Drug Administration (FDA) for a Phase I/II trial of this hRPCs therapy at Massachusetts Eye and Ear[41] in the US. The trial, which will begin in November 2016, will evaluate the safety, tolerability and effectiveness of the treatment in up to 15 patients with advanced RP.

MRC Grant Ref: MC_PC_13038

4.1.4 Research materials

Research materials include databases, data analysis techniques, cell lines, *in vitro* and *in vivo* models of mechanisms or symptoms, and new equipment created as a result of research. Such materials have considerable potential for re-use by other researchers in future applications and are therefore a highly beneficial output of MRC-funded research.

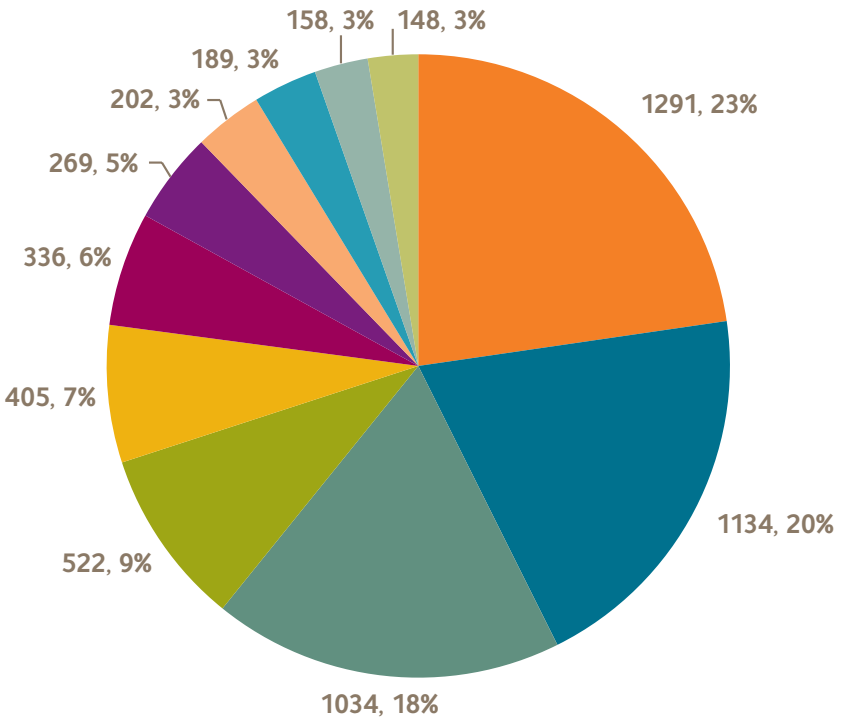
Researchers funded by MRC report new instances of *Research Materials* in researchfish®. However in 2013 the *Research Materials* section was subdivided into *Research Tools and Methods* and *Research Databases and Models*. This makes direct comparison with previous impact report data more difficult, as researchers adapt their reporting to the new subcategory question sets.

The proportion of awards reporting instances of *Tools and Methods* and *Databases and Models* were 28 and three respectively, with an overall proportion of 31 per cent for all *Research Materials*. As these subdivisions of research materials are not fully established, and for continuity with previous economic impact reports, we present *Research Materials* as a single class of outputs in this 2014/15 report. However with all Research Councils now aligned to a common platform and framework for collection via researchfish®, the reporting on research materials will be restructured for better cross-comparisons in future reports.

There are more than 5,600 instances of research materials reported by MRC researchers in researchfish®. *"Models of mechanisms or symptoms – mammalian in vivo"* were the most common type of research material reported (28 per cent), followed by "*database/collection of data/biological samples*" (19 per cent).

Figure 6 shows a breakdown of the distribution of type of research materials reported - see Annex 2 Section 4.1 Knowledge generation for specific figures.

Figure 6: *Distribution of research materials reported between 2006 to 2014 by type*



Specific examples of research materials:

Dr Nick Loman at the **University of Birmingham** has developed Poretools[42], the first published software that can analyse DNA sequencing data produced by Oxford Nanopore Technologies (ONT)[43].

ONT, a company formed by MRC-funded **University of Oxford** researcher **Professor Hagan Bayley** in 2005, developed a 'new-generation' of DNA sequencing technology using engineered protein membrane nanopores. The technology is able to detect single molecules and it is unnecessary to amplify the DNA which means that long fragments can be sequenced without losing quality.

In May 2014, ONT released MinION™, a portable device the size of a USB memory stick and costing under $1,000, for electronic single-molecule sensing. Sequencing with MinION produces raw signals that reflect the ionic current at each pore by a DNA molecule. The resulting files for each read sequence are stored in a format called 'FAST5'. However, until now, there has been no software available with the ability to analyse this data format.

Poretools, an open source tool, is able to convert data in the FAST5 format to either FASTA or FASTQ, both text-based formats representing nucleotide sequences, to enable the user to compare the data with sequence alignment and/or assembly software.

In 2014 Professor Loman and colleagues used this software to analyse a *Salmonella* outbreak at a hospital in Birmingham. Within two hours of receiving samples from the hospital, the researchers had sequenced the bacterium, confirmed that it was *Salmonella*, determined its strain and showed that all cases were part of the same cluster[44].

Professor Loman's team also used the software to sequence Ebola genomes in April 2015. As at September 2015, the team had sequenced 130 genomes and played an important role in tracking the transmission of the disease. The team have also confirmed that the MinIONs are now 90 per cent accurate—a significant improvement over their performance at launch[45].

MRC Grant Refs: MR/J014370/1 & G0300122

Professor Baron-Cohen, director of the **Autism Research Centre (ARC), University of Cambridge**, has developed a test that assesses a person's level of empathy in autism research studies.

Autism is a lifelong developmental condition that affects how a person communicates and relates to other people. It also affects how they see the world around them. As a spectrum condition, people with autism will share certain difficulties, but there are differences in the way it affects them. Some people may be able to live independent lives, but others will have accompanying learning difficulties and need lifelong specialist help. There are currently few behavioural or drug treatments available to improve the key social difficulties associated with autism.

Direct eye contact is considered to be one of the most important platforms for social interaction and communication in humans[36,47]. Sensitivity to information from the eyes and appropriate use of eye contact in social contexts may also help to develop more complex skills needed for social understanding and behaviour[48,49]. Professor Baron-Cohen has previously demonstrated that eye contact is reduced in many people with autism, beginning in early infancy and lasting into adulthood[50]. The *Reading the Mind in the Eyes* Test[51] and more recent Revised Eye Test[52] has become a respected experimental measure of subtle cognitive dysfunction. Such measures are relatively rare in social cognition studies, and Professor Baron-Cohen's work

therefore provides an important research tool and has been widely used in independent studies both in social cognition research and as a diagnostic measure of autistic severity.

MRC Grant Ref: G0600977

4.1.5 Awards and recognition

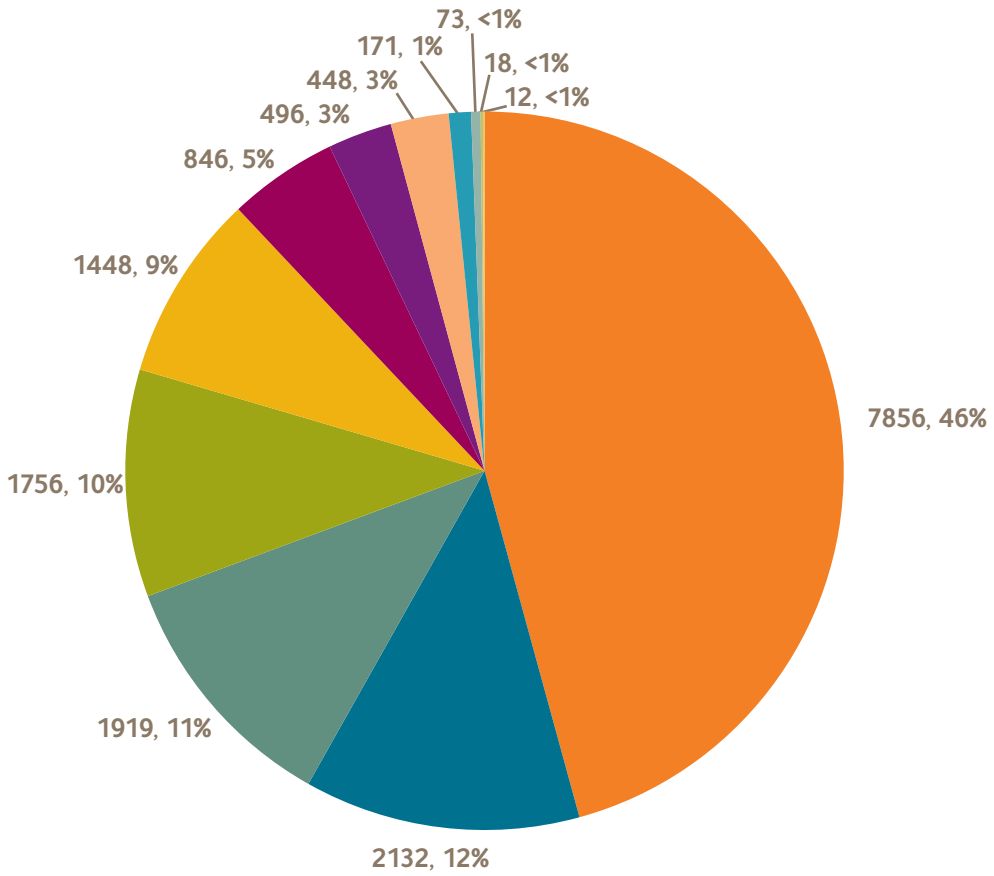
Measures of esteem can include awards and other evidenced forms of acknowledgement. It is an encouraging reflection of the reach and significance of MRC research that our researchers have secured the most highly prized awards in science including the Nobel Prize and the Louis-Jeantet Prize. Such international recognition is indicative that the MRC is following our strategic aim of supporting world class medical research.

While award winning quality does not necessarily correlate with high impact research there are certain measures, such as being appointed to the editorial board of a journal or attracting visiting staff, which can be seen to have a wider impact on the research and teaching community. Measures of esteem are also used internationally by some funders alongside citation analysis, peer review and research income as indicators of research quality[53].

Researchers made 17,175 reports in this section. Recipients of 52 per cent of awards reported that their work had resulted in such formal recognition for them personally or for members of their MRC-funded team. The average number of reports per award (of those reporting recognition) was seven (6.7). Ten or more instances of personal recognition were reported in nine per cent of all awards.

researchfish® captures information on the type of recognition reported. The most frequently reported type of recognition in 2014 was being personally invited as a speaker at a conference, in 46 per cent of awards reporting personal recognition. This was followed by being appointed to a prestigious/honorary/advisory position to an external body (12 per cent), research prize (11 per cent) and appointed to the editorial board or as an advisor to, a journal or book series (10 per cent). The distribution of types of recognition is shown in Figure 7.

Figure 7: *Distribution of awards and recognition reported from 2006 to 2014 by type*



Specific examples of awards and recognition:

Dr Niall Kent[54] at **University College London** won the **Royal Academy of Engineering's JC Gammon Award** in 2014 for his innovative dental bone graft material, Aerograft.

Bone replacements are used by dentists when a patient is missing bone or when more bone is required, for example, during implants. Aerograft is a synthetic material that is more effective than existing bone replacements and can be tailored to specific procedures. It is thought that Aerograft could be used in almost 600,000 dental operations worldwide each year. Very little progress has been made in this field in the past 50 years and so this presents a significant improvement to existing bone substitutes.

This award will grant Dr Kent access to support from some of the UK's most successful entrepreneurs and business leaders through membership of the Academy's *Enterprise Hub*[55]. The award also includes a prize of £15,000 for the growth of his start-up company.

MRC Grant Ref: MR/M025306/1

Professor Michael Owen, director of the **MRC Centre for Neuropsychiatric Genetics and Genomics** at **Cardiff University**, was awarded a **Knighthood** in the Queen's 2014 Birthday Honours for services to neuroscience and mental health.

Professor Owen's research into the genetic risk factors for complex psychological and neurodegenerative disorders such as Alzheimer's and schizophrenia has been funded by the MRC for more than 20 years. He has played a fundamental role in leading international collaborations, substantially increasing the number of genes identified to play a part in the development of Alzheimer's.

MRC Grant Ref: MR/L010305/1

4.2 Human capital (stock)

Funding for studentships is awarded to research organisations, including universities, MRC units, institutes and centres, who are responsible for selecting outstanding candidates for projects supervised by leading researchers. All MRC students receive at least the MRC's minimum stipend and allowances, including support for fees, a contribution to consumables and an annual travel and conference allowance.

Approximately 50 per cent of MRC studentship funding is provided through Doctoral Training Partnerships (DTPs) with universities. We have recently refreshed DTP allocations for students starting from 2016.

The focus of Doctoral Training Partnerships is to ensure that PhD students receive the highest-quality training provision aligned to world-class research. We believe it is important to maintain flexibility, within the terms and conditions of the award, for the universities in how they deploy their PhD students. In support of this, we piloted a flexible supplement in 2014/15 to provide more local discretion in providing career support and to enable high-cost and other important training opportunities for students. Following the success of this pilot, such supplements are now embedded in future DTP awards.

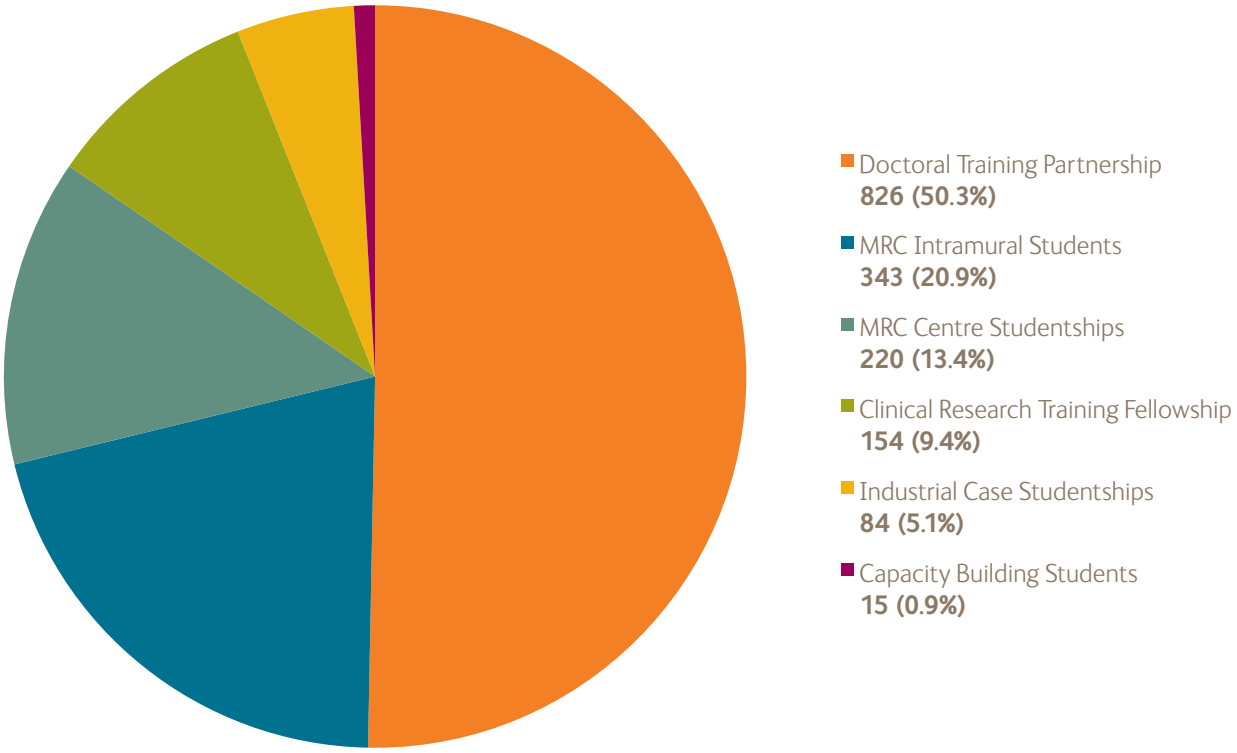
Doctoral Training Partnerships now also include consideration of capacity building in areas of scarce strategic skills to ensure a productive and nurturing training environment. Individual studentships in capacity-building areas are no longer funded separately. Partnerships are complemented by Industrial CASE studentships, which provide students with experience of collaborative research in a non-academic environment, with 27 individual awards made in 2014/15.

Studentship training is also aligned to the MRC's strategic investments, for example, in units, institutes and centres. Approximately 20 per cent of the MRC's studentship investment is delivered from within our units and institutes, with a further ~13 per cent delivered by centres. These PhD programmes link training and capacity building to the MRC's investment in a high-profile UK centre of excellence.

MRC also supports building research capacity amongst clinicians, and supports approximately 150 Clinical Research Training Fellowships (CRTFs)[56], clinicians completing PhDs, at any one time.

The total number of PhD studentships, including CRTFs, across the MRC's intramural and extramural programmes in March 2015 was 1,642[57], as shown in Figure 8. These are broken down by funding mechanism, showing the number and proportion of each.

Figure 8: *Number of live MRC-funded studentships as at March 2015*



In addition to PhD studentships, the MRC also invests in a limited number of research masters to assist research organisations (ROs) tackling unmet national needs for advanced biomedical and health research skills. This support will be embedded in MRC's Doctoral Training Partnerships (DTP)[58] in future, rather than as a stand-alone mechanism.

4.3 Knowledge transfer and exchange

A major focus for the MRC in recent years has been the translation of the results of basic science into improved healthcare, products and services. The MRC's translational research agenda aims – to drive innovation, speed up the transfer of the best ideas into new treatments, and improve the return on investment in fundamental research – and objectives are outlined in the MRC Strategic Plan.

The MRC works with the National Institute for Health Research (NIHR), NHS England, and the devolved health departments to ensure that we have integrated funding schemes, infrastructure and facilities to provide a pathway for research from laboratory to standard patient use.

Supporting collaboration between researchers and industry is an integral part of our strategy and at the heart of our mission to produce benefits for patients and growth in the UK economy. In 2014/15, we continued to develop and implement innovative new ways of working with companies to support this goal.

In January 2015 the MRC made four further stratified medicine awards totalling £13.7m to support partnerships between academic and industrial researchers in open innovation consortia targeting lupus, hypertension (in partnership with the British Heart Foundation), asthma and colorectal cancer (in partnership with Cancer Research UK). These awards are part of the MRC's £60m commitment in the current spending review period to stratified medicine and build on nine earlier consortium awards totalling £37.6m. Combined, the thirteen consortia in the MRC's stratified medicine portfolio bring together 32 academic and 51 industrial partners from the biopharmaceutical and diagnostics sectors, from across the UK and also from Europe, the US and wider afield, including China and Japan.

See Annex 2 Section 4.3 Knowledge transfer and exchange for a breakdown of numbers of awards and commitment for the relevant grant schemes.

Examples of outputs/impacts in this area:

The year 2014 was an exciting one for **Synairgen plc**.[59], the **University of Southampton** spin out set up by MRC-funded researchers. Its Phase II clinical data were published[60], showing that 'difficult-to-treat' asthmatics, those who respond poorly to conventional steroid treatment, experienced a 50 per cent reduction in moderate or severe exacerbations ('asthma attacks') from treatment with its novel drug SNG001 (inhaled interferon-ß).

Synairgen was founded in 2003 by world-renowned asthma specialists **Professors Donna Davies, Ratko Djukanovic** and **Stephen Holgate** at the University of Southampton. Professor Holgate received an MRC Clinical Professorship in 1987 to investigate the causes of asthma, which led to his discovery that cold and other viral infections worsened asthma attacks. Further work showed that in patients with asthma, the cells lining the lungs are unable to make sufficient levels of the anti-viral protein, interferon-ß, to eliminate the virus. Tests in virus-infected cells showed that this ability could be restored by adding interferon-ß back into the cells.

Synairgen's new interferon-ß treatment has "the potential to be one of the biggest breakthroughs in asthma treatments in the past 20 years"[61].

In 2014 the company signed an exclusive licence agreement with AstraZeneca[62] for the use of inhaled interferon-ß for the treatment of respiratory tract viral infections. This saw a $7.25 million upfront payment and potential development and

commercial milestones of up to $225 million as well as royalties on future sales. This deal again highlighted the importance of university spin-out companies.

AstraZeneca will begin further Phase II work in 2015 with the aim of bringing the drug to market at the earliest opportunity. The drug also has the potential to work in a similar way in patients with chronic obstructive pulmonary disease (COPD).

MRC Grant Refs: G0501506 & G0800766

SimOmics[63], formed in June 2014, results from more than seven years' work at the **University of York** by **Professor Jon Timmis**, Professor of Intelligent and Adaptive Systems in the university's electronics department and MRC-funded Senior Lecturer in Immunology, **Dr Mark Coles**. Electronics and immunology research might not be a traditional pairing. However, computing advances and new modelling techniques are increasingly offering cost and time-effective ways to explore the mechanics of biological systems.

The company has developed tools to support computer models that predict the effects of potential drugs and the immune system's response. By increasing the use of computer simulations, SimOmics aims to reduce the need for animal and patient trials and enable manufacturers to focus on the products most likely to succeed.

In 2014 the company was part of a multi-sector team securing almost £1m from the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs)-sponsored CRACK-IT programme[64]. This will fund the Phase 2 development of a computer-based "virtual laboratory" to aid the search for new treatments for leishmaniasis, a worldwide parasitic disease. The computer model will help to predict the effectiveness of different drugs, vaccines and other treatments. Using this technology is expected to significantly reduce the number of rodents needed for pre-clinical drug and vaccine development — a typical rodent study for new antibiotics or vaccines might involve up to 100 animals per candidate drug[65].

MRC Grant Ref: G0601156

4.4 Intellectual property activity

Intellectual Property (IP) is a key indicator in determining the technological innovation, competitiveness and economic benefit of research. For research funders, reports of IP give tangible evidence for the potential for translation of academic research into both economic and health benefit to society. Future investment is often dependent on patents and researchers may struggle to bring in further funding to develop new technologies without legal protections in place. Therefore intellectual property is often considered prerequisite to future societal impact.

MRC Technology (MRCT) is a key partner in our translational strategy. It translates cutting-edge scientific discoveries from MRC units and institutes into products and manages our intellectual property such as valuable patent rights associated with the production of monoclonal antibodies.

During 2011/12, changes were made to MRCT governance to strengthen its independence from the MRC. The organisation now works with the MRC under contract, and the MRC paid MRCT management fees of £4.62m in 2014/15.

MRCT manages both new intellectual property and commercial opportunities arising from research by MRC staff and existing MRC intellectual property and on-going licensing arrangements. In 2014, 42 patents were granted. Licensing income to the MRC from all MRCT-managed sources was £94.9m.

The data presented in this section is provided by MRCT. However the MRC also collects data on intellectual property via researchfish®. Researchers are asked to provide details and update the status of published, granted and/or lapsed patents. This is a larger dataset (1,081 since 2006) which may include the same IP reports as MRCT data.

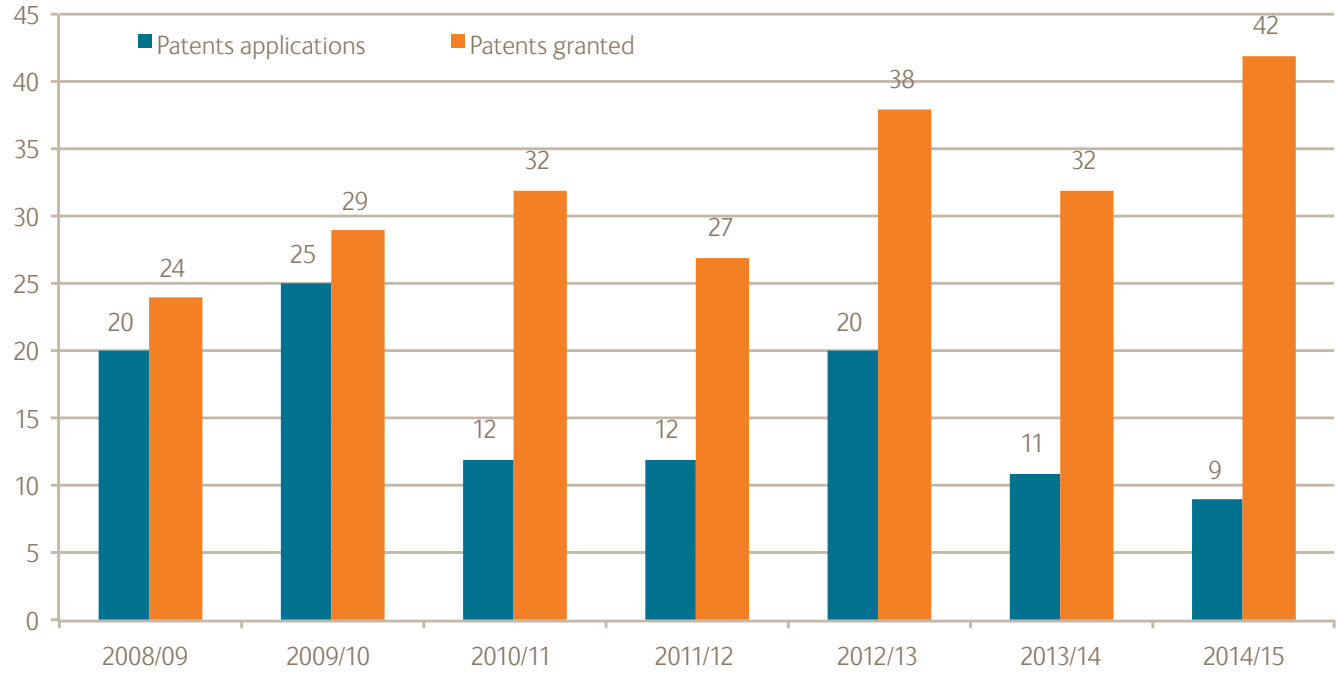
4.4.1a Patent applications and patents granted (MRCT)

MRCT works with scientists from MRC-funded units and collaborating organisations to discover and protect healthcare innovations.

The MRCT data on patents presented here represents the intramural part of the MRC portfolio only. Figure 9 shows the number of patent applications and patents granted by year. Note that the number of patent applications managed by MRCT over the past four years has decreased as MRC units are transferred to University control.

The number of patents granted indicates the number of patent families in which at least one patent has been granted. A patent family consists of the original patent application together with all patent applications filed worldwide. For MRC patents this can be between 2 and more than 20 patent applications. Once granted a patent has a term of 20 years from the first patent filing (for most jurisdictions), after which the patent will expire. It can take more than 3 years for a patent to be granted and often longer so there is a lag between the original patent filing and a granted patent which is variable dependent on the country the patent application is being prosecuted in. Finally, patents can be retracted or challenged during prosecution which causes further delays or declare patents invalid. All these variables contribute to the fluctuation of granted patent numbers over time.

Figure 9: *Number of patent applications and patents granted by financial year (MRCT data)*



4.4.1b Patent applications and patents granted (researchfish®)

Intellectual property generated by MRC-funded research outside of MRC institutes and units belongs to the researchers and institutions in which the research is conducted. Patent information is therefore also collected directly from MRC-funded researchers through researchfish® to quantify IP discoveries outside of the scope of MRCT management.

Since 2006 there have been 1,081 discoveries reported in the intellectual property section. Twenty three per cent of discoveries overall (246/1,081) were reported as 'licensed' by 2014. The proportion is slightly higher for patented discoveries not yet licensed (65 per cent, 703/1,081). This is similar to the proportions reported in the last three years. This calculation does not include the 12 per cent of reports where researchers indicated that details were 'commercial in confidence' and could not be provided (132/1,081); it would be reasonable to assume that some of these cases will translate into new licences in due course.

4.4.2 Spin-outs/new businesses created

MRCT has managed the creation of two new businesses in the last seven years directly from the MRC's intramural programme.

The MRC also collects data on spin-out companies directly from researchers through researchfish®. MRC funding has contributed to the set up or growth of 88 companies, 71 of which have been formed since 2006, including seven in 2014. It is estimated that these 88 companies represent 100 to 300 new highly-skilled jobs in the UK.

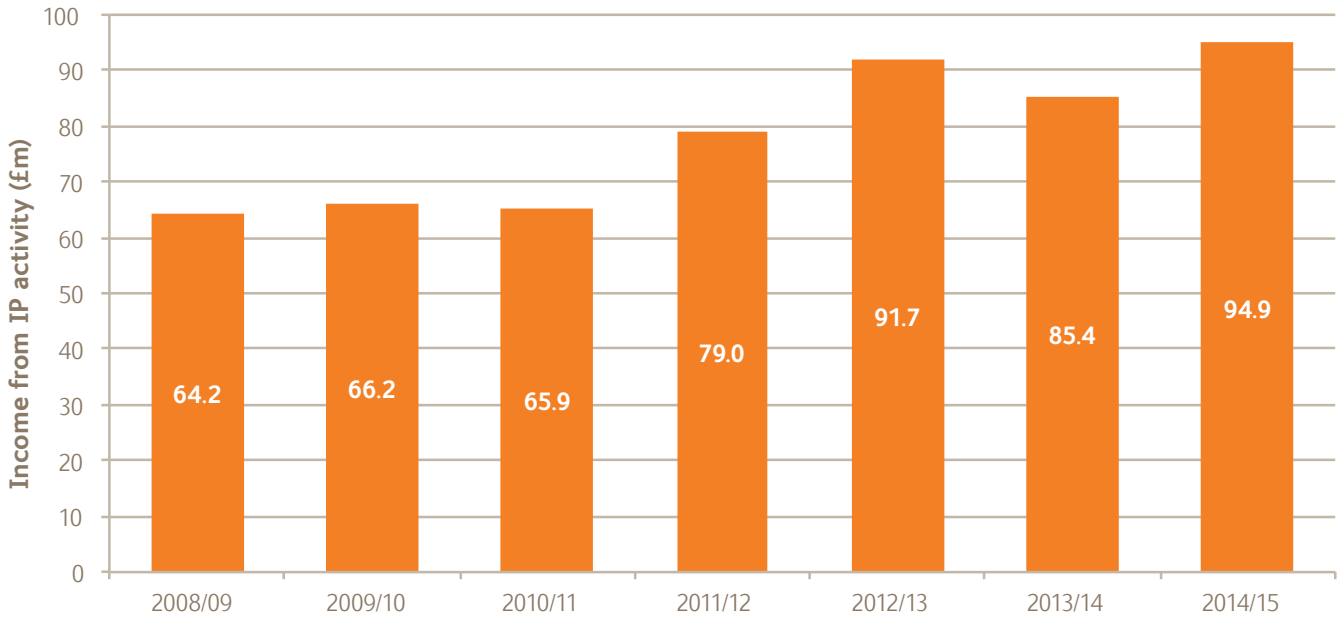
See both Annex 2 Section 4.4a Intellectual Property Activity (MRCT-managed) and Section 4.4b Intellectual Property Activity (researchfish® data), for a breakdown of the data on patents and spin-outs.

4.4.3 Income from MRCT-managed intellectual property

Between 2008-10 and 2011-14 there were significant increases in income from products (Tysabri™, Actemra™ and Soliris™) developed by companies who have a license to the Winter 1 patents. Another major increase was due to income from antibodies including Vectibix™, Prolia™, Xgera™, Ilaris™, Arzerra™, Yervoy™, Stelar™, from MRC's transgenic mice patented technology. Income from licenses to this particular technology rose from £3.4m to £13.9m between 2010/11 and 2011/12.

Figure 10 shows the income from MRCT-managed intellectual property.

Figure 10: *Income from intellectual property (IP) by financial year (MRCT data)*



Specific examples of commercialisation (reported in researchfish®):

Dr Fillip Port and **Dr Simon Bullock** at the **MRC Laboratory of Molecular Biology (LMB)** have licensed optimised genome modification tools for the model organism *Drosophila* to three commercial companies that produce transgenic *Drosophila* flies for the research community.

Researchers at the University of California reported in 2012 that an immune system in bacteria that could cut open and make a change to an invading virus' DNA could be modified to recognise, and subsequently change, any DNA sequence[66]. The CRISPR system uses an enzyme called Cas9 to cut specific DNA sequences when guided to a particular site in the genome by short RNA molecules.

Since 2012, CRISPR has been used as a simple and versatile gene modification tool in many model organisms and in cultured mammalian cells. Many MRC-funded researchers are using CRISPR to identify and characterise genes implicated in particular diseases.

Drs Port and Bullock have generated transgenic flies expressing Cas9 and plasmids for producing the guiding RNA molecules. These tools have been distributed widely to the academic research community, being used by more than 300 laboratories[67]. The tools have been licensed to the three commercial companies under royalty-bearing agreements.

MRC Grant Ref: MC_U105178790

Professor Dlawer Ala'Aldeen at the **University of Nottingham** patented a way to prevent or reduce *campylobacter jejuni* (*C. jejuni*) bacteria colonisation in poultry in 2013[68].

Campylobacter is the most common cause of food poisoning in the UK, with approximately 280,000 cases each year; more than *Salmonella*, *E. coli* and *Listeria* combined[69]. Around 80 per cent of cases of *Campylobacter* poisoning in the UK come from contaminated poultry. The latest report from the Food Standards Agency (FSA) revealed that 73 per cent of shop-bought chickens are contaminated with the bacterium, with 19 per cent testing positive at the highest level[70].

The infection causes symptoms such as severe diarrhoea, abdominal pain, fever, and sometimes vomiting. Infection can sometimes lead to other complications such irritable bowel syndrome (IBS) and, rarely, Guillain-Barré syndrome – a serious and sometimes permanent condition of the nervous system.

The FSA estimates that the infection causes more than 100 deaths each year in the UK and that the annual cost to the economy is £900 million[69]. However, its prevention and treatment have been hindered by a poor understanding of the molecular interaction between the host and bacteria.

In 2014 Professor Ala'Aldeen and his team reported that they had identified two bacterial surface molecules; flagellin protein (FlaA) and major outer membrane protein (MOMP), that bind to human and poultry epithelial cells[71]. Professor Ala'Aladeen has also shown that the adherence of *C.jejuni* to epithelial cells can be partially inhibited by human histo-blood group antigens (BgAgs). BgAgs are sugars that are expressed on the surface of epithelial cells, such as the cells lining the gastrointestinal tract and can be secreted in bodily fluids such as saliva and breast milk. The patent therefore covers natural or synthetic BgAg compounds that bind to FlaA or MOMP to block the bacterium's interaction with poultry cells. Such compounds could reducing poultry colonisation and therefore inhibit transmission to humans, preventing subsequent infections and the risks to human health.

MRC Grant Ref: G0901696

Outcomes | 5.0

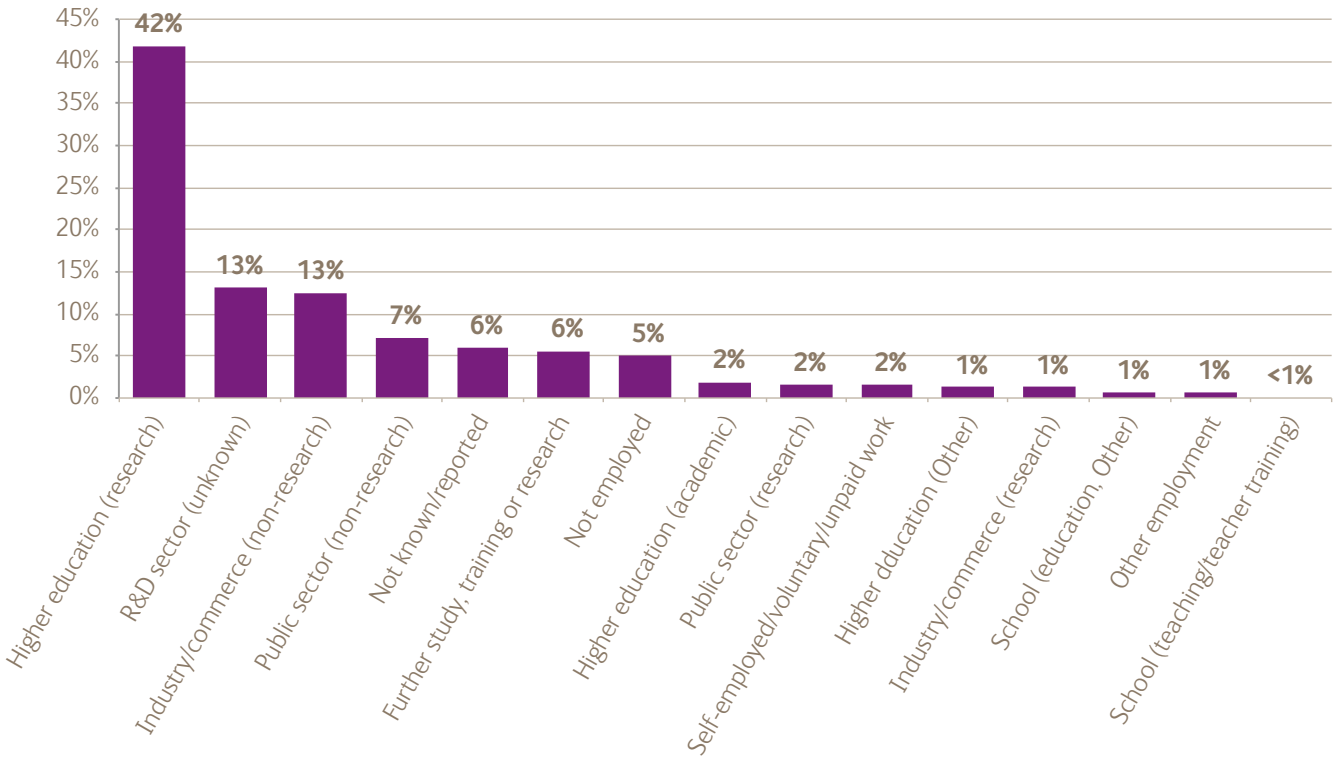
5.0 Outcomes

5.1 Human capital (flow)

The Higher Education Statistics Agency (HESA) DLHE (Destinations of Leavers from Higher Education) survey provides information about patterns of employment and further study or training of MRC-funded PhD students by six months after completion.

Figure 11 shows the first destination information for MRC PhD students who completed their programmes during the academic year 2013/14 (1 August 2013 to 31 July 2014).

Figure 11: *First destinations of MRC-funded students who completed programmes during the academic year 2013/2014*



These data demonstrates that six months after completing an MRC PhD, 89 per cent of students are known to be in employment or engaged in further study. This is slightly higher than average graduate employment rates of ~81-87 per cent[72].

Just over 58 per cent of MRC students went on to research-related employment, mostly in the higher education sector (42 per cent). An additional five per cent of students continued in further study, training or research while 26 per cent were in non-research related employment. Just five per cent registered as unemployed and six per cent are listed as unknown status.

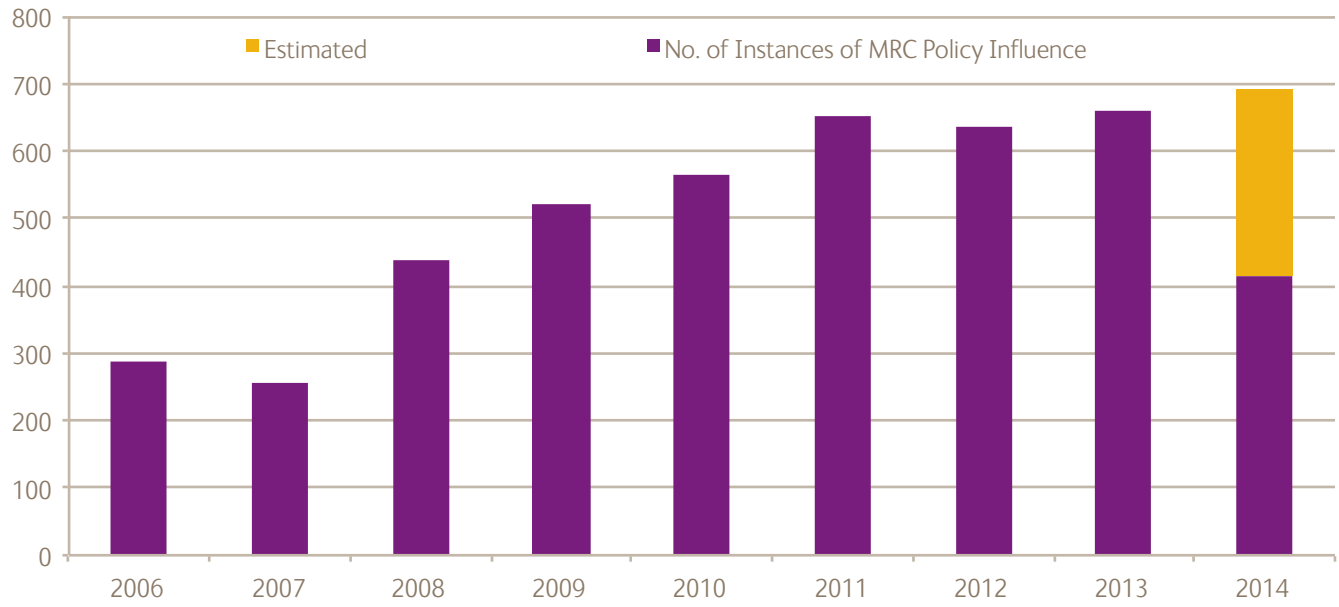
These data remain consistent with previous academic years, showing that MRC studentships continue to be desirable qualifications for future employment with a high propensity for research-related activities. Further data on this are available in Annex 2 section 5.1 Human capital (flow).

5.2 Public policy

Research in areas such as the relationship between health, diet and the choices we make, or the effect of the environment that we live in on health, are areas that often result in public health interventions and policy changes rather than commercially exploitable 'products'. These are equally important outcomes to monitor as they often have a substantial impact on the public and result in significant impact on health or wellbeing. Information about the influence that MRC-funded research and MRC-funded researchers have on policy and practice is collected through researchfish®.

There were 4,452 reports of policy influences between 2006 and 2014. Figure 12 shows the instances of influence on policy by the year that it was realised[73]. Please see Annex 2 Section 5.2 Public policy for more specific figures.

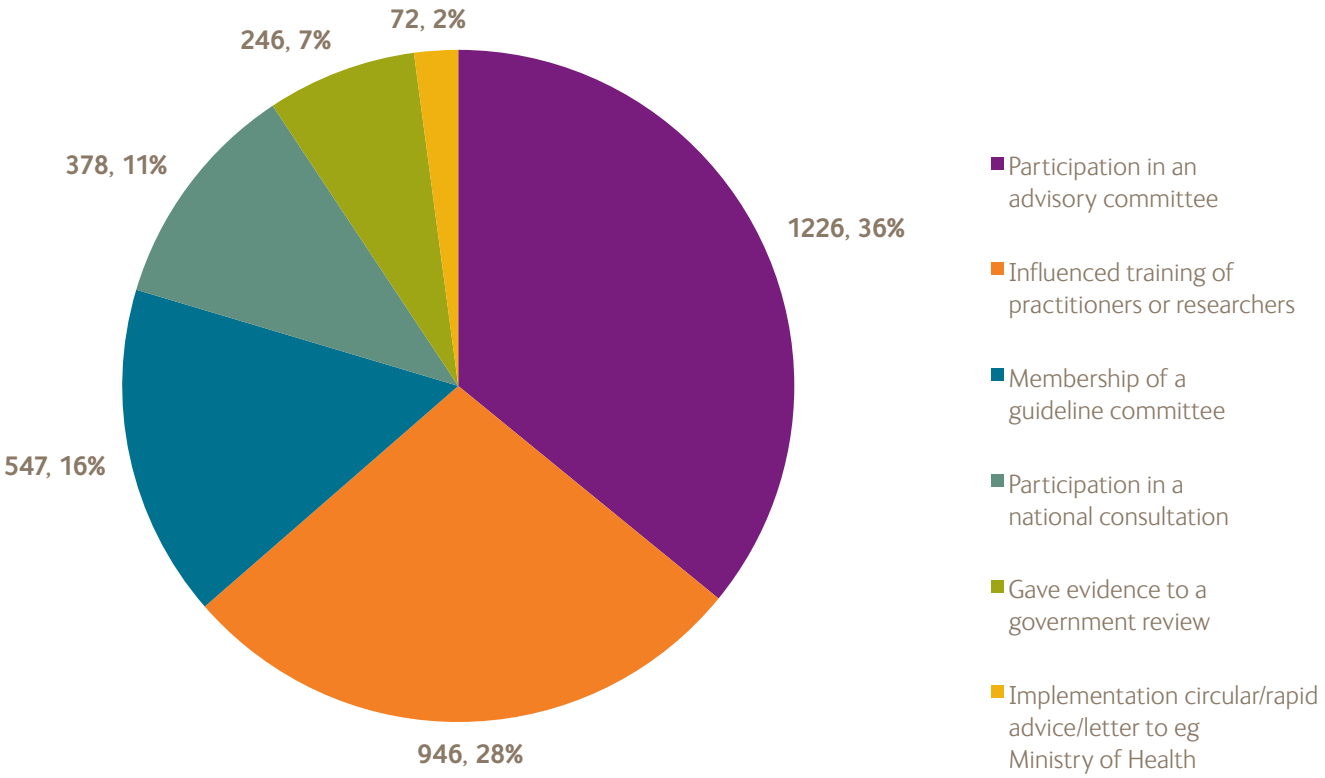
Figure 12: *Number of reports of influence on policy by year*



Each influence on policy is reported as a specific 'type', such as 'citation in clinical guideline' or 'participation in national consultation'. These types fall into two categories – 'influences on the policy-setting process' and 'value/changes induced via citation in policy documents' and are shown in the metrics below.

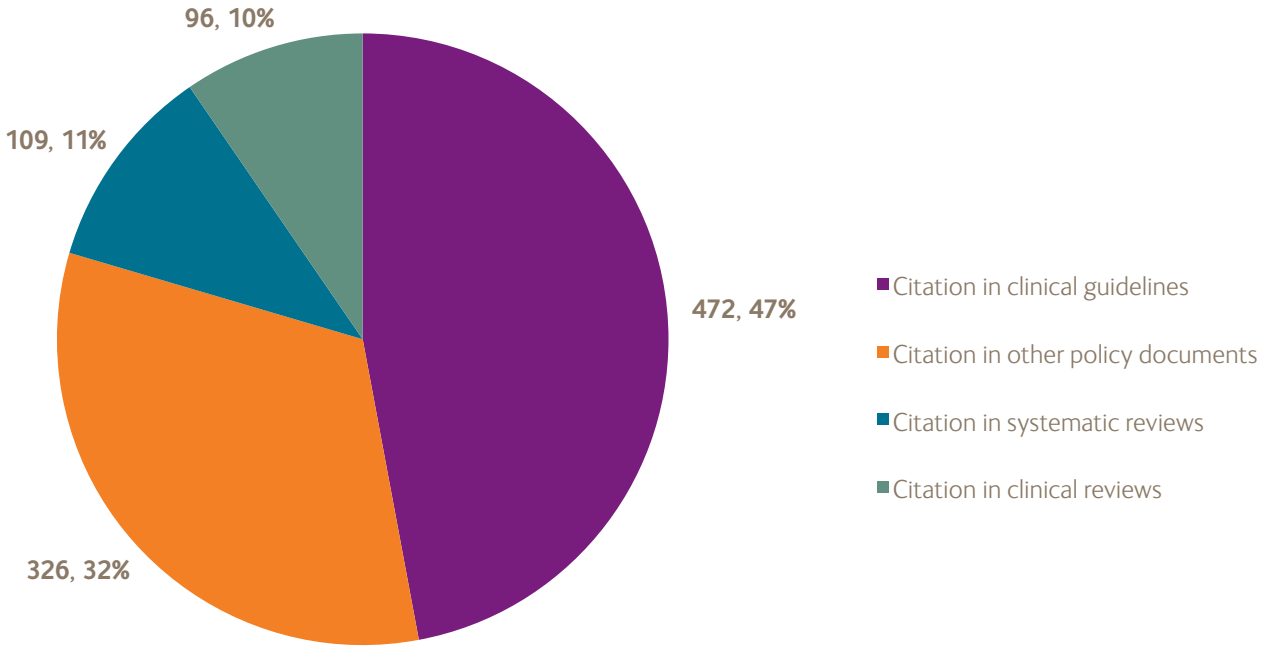
There were 3,415 reports of influences on policy-setting processes reported between 2006 and 2014. Figure 13 shows the breakdown by type of policy-setting process with specific numbers and proportion.

Figure 13: *Distribution of policy setting processes reported from 2006 to 2014 by type*



There were 1,003 reports of value/policy changes induced through citation in key policy documents reported between 2006 and 2014. Figure 14 shows the breakdown by type of policy document with specific numbers and proportion.

Figure 14: *Distribution of value/changes via citation in policy documents reported from 2006 to 2014 by type*



Specific examples of influences on policy:

Work at the **MRC Centre for Outbreak Analysis and Modelling** at **Imperial College London** has helped to inform and stimulate the international response to the recent Ebola epidemic.

The Ebola outbreak was first reported to the World Health Organization (WHO) in March 2014, tracing the initial infection back to a small village in south-eastern Guinea in December 2013[74]. However, it wasn't until the summer of 2014 that there was sufficient information available to appreciate the scale of the problem. The outbreak had quickly become the deadliest occurrence of the disease since its discovery in 1976.

A team of more than a dozen researchers at Imperial College conducted vital work analysing the line lists – information on where the patients lived, who they were in contact with, their demographics and symptoms. They were able to track the spread of the epidemic through time to estimate the transmission rate and incubation period. By linking the Ebola cases together, the researchers were able to determine the risk factors for transmission and to identify the most effective interventions for agencies on the ground.

This work was used to provide reports on the current Ebola epidemic to the World Health Organization (WHO), which based on this analysis declared the epidemic to be a "public health emergency of international concern in August 2014"[75]. As at 21 October 2015, the total number of reported cases was 28,476 and the number of deaths 11,298[76].

This work also fed into a report published in the New England Journal of Medicine (NEJM) in October 2014[77] which documented current trends in the epidemic and projected expected case numbers for the following weeks if control measures were not enhanced. The report made various recommendations, such as reducing the length of time from symptom onset to hospitalisation to curtail transmission in the community. The individual fatality rate was also lower for hospitalised patients.

In addition to helping steer the emergency relief efforts in West Africa and controlling the epidemic, the evidence helped convey the seriousness of the situation, providing support for the public funding from Governments and charities. It is also important to note the contribution that such "real world" analysis of epidemics makes to UK resilience as the methods are also applied to monitoring and modelling disease outbreak scenarios in this country.

MRC Grant Ref: MR/K010174/1

Professor Rustam Al-Shahi Salman is an academic clinician at the **University of Edinburgh** who studies cerebral haemorrhages, or bleeds on the brain. Cerebral haemorrhages occur when a blood vessel bursts in the brain. They cause around 15 per cent of all strokes, and affect about 10,000 adults in the UK — and about 1.5 million adults worldwide — each year.

Professor Al-Shahi Salman has recently shown that treating patients with arteriovenous malformations in the brain increases their risk of stroke when compared to not treating them. An arteriovenous malformation (AVM) is a tangle of blood vessels with the arteries directly connected to the veins. This means that blood from the arteries drains directly into the veins without stopping to supply the normal tissues in that part of the body with oxygen and nutrition.

AVMs can occur in any part of the body but most commonly in the brain or spine. They contain weakened blood vessels which may burst from the high pressure of blood flow from the arteries, causing bleeding, which in the brain can lead to brain damage

and death. Brain AVMs affect approximately one in 2,000 people and around one per cent of affected adults suffer a stroke as a result of their AVM each year.

However, Professor Al-Shahi Salman has found that over a 12-year period, patients who chose not to have their AVM treated by trying to remove or block the tangle of blood vessels were less likely to have a stroke or die from related causes[78].

In 2014, Professor Al-Shahi Salman was appointed to the American Heart Association guidelines committee for arteriovenous malformations of the brain. The guidelines, due to be published in 2016, will include the results of his study.

Professor Al-Shahi Salman says, "There are few AVM guidelines other than those produced by the AHA, so the AHA's guidelines tend to affect practice worldwide. This edition of the guidelines will be influenced by our population-based study and the ARUBA randomised trial that my group oversaw in the UK."

MRC Grant Ref: G108/613

5.3 Public engagement

One of the aims in the MRC's strategic plan, *Research Changes Lives*[79], is to bring the benefits of excellent research to all sections of society. This is supported by a specific objective to enhance engagement and communication with our scientists and partners, policymakers and parliamentarians, and the public. This confirms our duty, as set out in the MRC's mission, to engage with the public and other groups, to give an account of our research, to ensure that public views and concerns are reflected in our decision-making and to build public trust in the MRC and the research it funds.

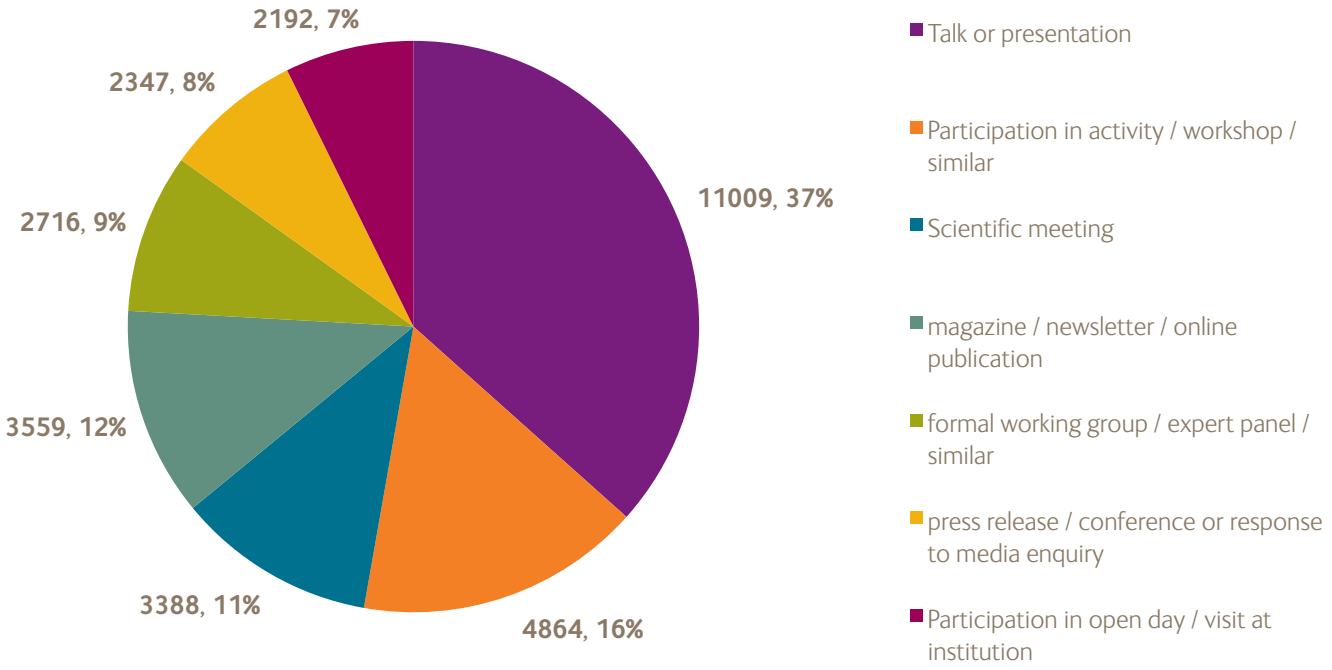
researchfish® collects information about public engagement and dissemination activities delivered by MRC-funded researchers. They are asked to report on their interaction with non-academic audiences. These include giving a public talk about their research to a non-scientific audience, working with journalists to share research findings via the media or taking part in a public science festival. For further examples, see the case studies on page 51 or the *MRC Outputs and Outcomes* report[80].

Between 2006, when data collection began, and 2014, MRC-funded researchers reported 30,075 distinct dissemination activities, from 53 per cent of awards.

Public engagement events by type

Figure 15 shows the breakdown by type of engagement activity with specific numbers and proportion. Further data on this can be found in Annex 2 Section 5.3 Public Engagement.

Figure 15: *Distribution of public engagement activities reported from 2006 to 2014 by type*



Funding for public engagement

Engagement with the public is delivered directly by MRC-funded researchers who interact with a wide range of audiences including patient groups, local communities and schools, and these activities are funded from core budgets. In addition, the MRC has a corporate budget for public engagement – £345,000 in 2014/15 – which includes small grants for researcher-led public engagement projects such as taking activities to popular music festivals and creating resources for schools.

Researchers are supported in their public engagement work by a network of MRC communications managers who offer help and advice and work with them to make the best use of available resource to achieve their public engagement goals.

Face-to-face engagement

Following the success of the MRC's centenary programme in 2013, several MRC institutions built on their public engagement activities and delivered them again, either in their own buildings or at festivals and events organised by others. MRC scientists are increasingly creating public engagement opportunities in places not traditionally associated with science, such as music festivals and comedy clubs, and are thus reaching new audiences.

Public engagement activities and events generate considerable legacy in terms of building awareness, interest and support for the MRC and its work, as demonstrated by the pick-up of leaflets and magazines at events and increasing numbers of followers on social media. In the space of one year, the MRC's followers on Twitter grew by around 25 per cent, to more than 20,000 individuals. Legacy is also seen in developing a group of researchers and support staff with improved awareness of the benefits of public engagement and increased advocacy for engagement within their institutions.

Media engagement

An important part of the MRC's public engagement programme is using media channels to reach public audiences and raise awareness of the MRC and its work. Between 2006, when data collection began, and 2014, MRC-funded researchers reported

1,854 separate media activities. Much of this work is driven and supported by the MRC press office. In 2014 this resulted in extensive media coverage featuring scientific achievements and new discoveries by MRC-funded researchers, more than 1,400 of which mentioned the MRC. Media coverage was spread across all news channels – print, broadcast and online – and was carried by both national and regional newspapers and programmes.

Social media

The MRC encourages and supports its scientists in using social media to share the ambitions and outcomes of their research. This is an increasingly important medium which allows direct engagement between researchers and members of the public. The MRC community's social media presence is supported corporately on Twitter, YouTube and Facebook, all of which amplify information from researchers and drive followers to relevant websites with more information.

The MRC's blog, *Insight*[81], provides an interactive channel where the context and significance of MRC decisions and discoveries can be shared and discussed with public audiences. *Insight* has attracted more than 106,000 unique visitors since it was launched in June 2012.

Specific examples of engagement activities:

Professor Chris Ponting is a professor of genomics — the study of genome structures, function, evolution and mapping — at the **University of Oxford**. He has contributed to many landmark genome sequencing projects, including sequencing the human, mouse, rat and chicken genomes. The primary focus of his research is using genome-scale data sets to identify or prioritise genes that are mutated in human disease.

Supported since 1999 with more than £6m in MRC funding, Professor Ponting and colleagues published research in 2014 suggesting that only 8.2 per cent of the human genome was functional[82]. To reach this figure, the researchers identified how much of our genome had avoided being changed over 100 million years of mammalian evolution. They took this to indicate that this DNA has important functions that need to be retained. This finding will speed up the ability to track down genetic mutations in disease as researchers can prioritise genetic differences that occur in the conserved portion of the genome. This research received extensive media coverage, including articles published in *The Telegraph*[83] and the *Daily Mail*[84].

MRC Grant Ref: MC_U137761446

Research by MRC-funded PhD student **Camilla Nykjaer** at the **University of Leeds** on the link between light drinking by pregnant women and pre-term birth led to national media coverage and the Royal College of Obstetricians and Gynaecologists (RCOG) changing its guidance on alcohol consumption.

Evidence about the damaging effects of heavy drinking in pregnancy is well-established. However, the link between light alcohol consumption and adverse outcomes, such as pre-term labour and low-birth weight, is less clear. The current guidance issued by the Department of Health is that pregnant women and women trying to conceive should avoid alcohol altogether and never drink more than 1–2 units once or twice a week.

Camilla used data from the Caffeine and Reproductive Health (CARE) Study[85], a prospective cohort of 1,303 pregnant women aged 18-45 years. The study used questionnaires to assess alcohol consumption before pregnancy and for the three trimesters

separately. Camilla found that the association with adverse birth outcomes such as low birth weight and pre-term birth were strongest in pregnant women consuming more than two units of alcohol a week and in trimesters one and two. However, the study also showed that even women adhering to the Department of Health guidance in the first trimester still doubled their risk of giving birth to a premature or underweight baby[86].

Camilla gave interviews with various media outlets, resulting in national coverage including articles by the *BBC*[87], and *The Times*[88].

Following this media interest, Camilla was approached by the Royal College of Obstetricians and Gynaecologists (RCOG) to review their guidance on alcohol consumption in pregnancy. The resulting guidance, recommending that women trying to conceive and pregnant women in the first trimester do not consume any alcohol at all, was published in February 2015[89].

MRC Grant Ref: MR/K500914/1

Annexes

Annex 1: New Metrics Framework – BIS 2011/12

CATEGORY METRIC	UNITS	DEFINITION	
Income			
Total Funds Available	£m	Total funding available to the Research Council - Sum of Grant in Aid and Leverage	0
Budget Allocation	£m	Research Council Grant-in-Aid	0
Leverage	£m	Funding other than Grant-in-Aid. Sum of components below	0
of which Private	£m	Funding Leveraged from the Private Sector	0
of which from other Research Councils	£m	Funding Leveraged from other Research Councils	0
of which from other source	£m	Funding received from all other sources.	0
of which Private	%	As a percentage of Total Funds Available	0
of which Other Research Councils	%	As a percentage of Total Funds Available	0
of which Other	%	As a percentage of Total Funds Available	0
Total Expenditure			
of which Responsive Mode Grant	£m	Accounts Expenditure on Responsive Mode Grants	0
of which Postgraduate Awards	£m	Accounts Expenditure on Postgraduate Student Support	0
of which Other components	£m	Residual Expenditure on other components as Total funding minus two above	0
of which Responsive Mode Grant	%	As a percentage of Total Funds Available	0
of which Postgraduate Awards	%	As a percentage of Total Funds Available	0
of which Other components	%	As a percentage of Total Funds Available	0
Human Capital			
Principal Investigators	#	Total number of principal investigators directly supported on DATE	0
Research Leaders in Sponsored Institutes	#	Total number of research leaders in sponsored institutes where applicable on DATE	0
Research Fellowships	#	Total number of Research Fellowships on DATE	0
Knowledge Generation			
Number of Grants assessed for reporting	#	Number of grants assessed to which the outputs reported refer	0
Refereed Publications	#	Number of papers published in peer reviewed journals	0
Non Refereed Publications	#	Publications OTHER THAN those included under Refereed Publications	0
Co-authorship of refereed publications - International	#		0
Co-authorship of refereed publications - Industry	#		0
Human Capital			
Number of PhD Students Supported	#	Number of NEW PhD students supported on DATE	0
Number of Masters Students Supported	#	Number of NEW Masters students supported on DATE	0
Number of Other Students Supported	#	Number of New Non PhD or Masters Students supported on DATE	0

CATEGORY METRIC	UNITS	DEFINITION	
Finishing Rates	%	Percentage of PhD students submitting within 4 years of commencement of support (for example row 2007/08 refers to students who began in 2003/04)	O
Student funding/training schemes			O
Knowledge Transfer and Exchange			
KE Spend	£m	Total spend for relevant year across all council KTE programmes	O
KE Programmes		Please State which KE programmes you support	O
Commercialisation Activities			
IP Activity (discretionary)			
Patents applications	#	Patent Applications to RC investments	O
Patents granted	#	Patents Granted to RC investments	O
Spinouts/new businesses created	#	Number of new spinouts created from RC investments	O
Income from IP activity	£m	Income from IP including areas such as licence income and receipts from sales of shares in RC funded companies.	O
Human Capital			
Destinations of leavers		Total Number of leavers from Doctoral Programmes in this academic year (DLHE)	O
Of which University	%		O
Of which Wider Public Sector	%		O
Of which Third Sector	%		O
Of which Private Sector	%		O
Of which Unknown or Other	%		O
Of which Unemployed	%		O
Placements in user organisations	#	Count instances of funded placements in user organisations	O
Placements in user organisations		Examples of measured impact	O
Public Policy			
Instances of influence		Examples of influence in policy	O
Value/changes induced		Examples of measured impact	O
Public Engagement			
PE Schemes		Examples of PE Schemes	O

Key: O =to include O = optional O = data not available

The MRC has also chosen to include additional metrics and/or narrative information on:

- Non-paper outputs (part of section 4.1)
- Translational research and knowledge exchange (section 4.2)
- Public engagement (section 5.3)

Annex 2: MRC metrics

Section 3.1 Income and expenditure										
No.	Metric	Unit	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	From Annual Report Financial Statements
1	Budget Allocation	£m	680.8	722.2	732.0	697.5	656.2	725.8	703.5	Section 3
2	Leverage (MRC definition[90])	£m	693.7	739.0	745.9	702.1	659.6	729.3	707.0	Budget Allocation + Other (metric 1 + metric 2c).
2	Leverage (BIS definition[91])	£m	63.4	77.1	67.6	56.5	68.3	66.9	61.7	External Income (metrics 2a, 2b & 2c).
2a	of which Private	£m	44.6	50.6	42.5	42.1	49.2	48.3	41.6	Section 5, total less metric 2b
2b	of which from other Research Councils	£m	5.8	9.6	11.2	9.8	15.7	15.1	16.6	Section 5
2c	of which from other source – Other Income[92]	£m	13.0	16.9	13.9	4.6	3.4	3.5	3.5	Section 6
2d	of which from other source - Licences and Shares[93]	£m	64.98	66.19	61.69	78.98	91.72	85.42	94.89	Section 2
3	Total Expenditure	£m	349.6	383.6	384.3	414.1	423.7	517.3	531.3	Sum of metrics 3a to 3d
3a	of which Responsive Mode Grant	£m	229.5	249.3	264.5	267.6	243.1	272.5	305.1	Section 11
3b	of which Postgraduate Awards	£m	67.9	78.2	78.7	86.0	71.3	62.9	63.9	Section 2 & 13[94]
3c	of which Other components - Other Research	£m	36.9	38.3	23.2	42.2	91.5	164.2	145.7	Section 12
3d	of which Other components - International Subscriptions	£m	15.3	17.8	17.9	18.3	17.8	17.7	16.6	Section 14

Section 3.2 Human Capital (input - stock)										
No.	Metric	Unit	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Notes
4	Principal Investigators on grants	#	1006	1081	1041	958	1050	1021	1153	Data are expressed in terms of posts at December (for 07/08 to 11/12), August (for 12/13) or March (for 13/14 to 14/15). This is the number of distinct people. Where a person holds more than one grant they have been counted only once.
5	Research Leaders in Sponsored Institutes	#	349	346	289	237	239	246	357	Data are expressed in terms of posts at December (08/09 to 12/13) or March (13/14 to 14/15).
6	MRC-funded fellows	#	368	362	387	376	351	384	394	Data are expressed in terms of posts at December (for 07/8 to 11/12) or March (for 12/13 to 14/15). This figure includes Clinical Research Training Fellowships. This is the number of distinct people: where a person holds more than one grant (eg project grant in addition to their fellowship), they have been counted only once.

Section 4.1 Knowledge Generation

Paper outputs[95]

No	Metric	Unit									
7	Number of Grants assessed for reporting	5,095 submitted returns through researchfish®.									
		Year	2006 or earlier	2007	2008	2009	2010	2011	2012	2013	2014	Total
8	Refereed Publications (publication year)[96]	#	3,661	4,761	5,742	6,647	7,335	7,943	8,816	9,799	8,590 (partial) 9,953 (estimate)	63,294 (partial) 64,657 (estimate)
		The data gathering period for researchfish® in 2014 was October and November, therefore the figures for 2014 are partial. As such a projection for the full year has been estimated.										
9	Co-authorship of refereed publications - International	30,436 (50%)	50% of MRC funded peer reviewed papers published between 2006 and 2014 which have at least one author from outside the UK.									
10	Co-authorship of refereed publications - Industry	2,272 (4%)	4% of all MRC funded peer reviewed papers published between 2006 and 2014 have at least one author from the private sector.									

No	Metric	Unit									
		#	1,645	980	1,362	1,685	1,864	1,737	1,916	1,809	974	13,972
		Number of collaborations reported with at least one partner in the relevant sector.										
11	Collaboration											

Sector	# as of 2014	%
Academic	10,373	67
Non-Profit	1,027	7
Learned Society	3	<1
Multiple	0	0
Private	1,270	8
Public	1,361	9
Hospital	1,066	7
Unknown	332	2
Total	**15,432**	**100**

No	Metric	Unit	No Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
12	Medical Products or Interventions[97]	#	1	52	31	64	130	176	147	143	205	126 (partial) 221 (estimate)	1,075 (partial) 1,170 (estimate)

Type of Medical Products or Interventions	# as of 2014	%
Diagnostic Tool - Imaging	66	6
Diagnostic Tool - Non-Imaging	177	16
Health and Social Care Services	12	1
Management of Diseases and Conditions	69	6
Preventative Intervention - Behavioural risk modification	47	4
Preventative Intervention - Nutrition and Chemoprevention	13	1
Preventative Intervention - Physical/Biological risk modification	6	1
Products with applications outside of medicine	6	1
Support Tool - For Fundamental Research	80	7
Support Tool - For Medical Intervention	56	5
Therapeutic Intervention - Cellular and gene therapies	62	6
Therapeutic Intervention - Complementary	4	0
Therapeutic Intervention - Drug	317	29
Therapeutic Intervention - Medical Devices	28	3
Therapeutic Intervention - Physical	14	1
Therapeutic Intervention - Psychological/Behavioural	64	6
Therapeutic Intervention - Radiotherapy	10	1
Therapeutic Intervention - Surgery	19	2
Therapeutic Intervention - Vaccines	47	4
Total	**1,097**	**100**

No.	Metric	Unit	Pre-2006/ Unknown	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
13	Research Materials[98]	#	2,090	482	281	402	597	604	561	580	283	308 (partial) 400 (estimated)	6,188 (partial) 6,280 (estimated)
13a	Tools and Methods	#	1922	473	273	389	578	575	541	533	202	170	5656
13b	Databases and Models	#	168	3	5	8	10	20	12	29	46	74	375

Type of Research Material	# as of 2014	%
Antibody	189	3
Biological samples	537	9
Cell line	336	6
Data analysis technique	405	7
Database/Collection of Data/Biological Samples	497	9
Improvements to research infrastructure	522	9
Model of mechanisms or symptoms - human	202	4
Model of mechanisms or symptoms – human	0	0
Model of mechanisms or symptoms - in vitro	148	3
Model of mechanisms or symptoms - mammalian in vivo	1,291	23
Model of mechanisms or symptoms - non-mammalian in vivo	158	3
Physiological assessment or outcome measure	269	5
Technology assay or reagent	1,134	20
TOTAL	**5,688**	**100**

No.	Metric	Unit	No Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
		#	21	829	943	1,388	1,908	2,630	2,698	2,668	2,391	1,654 (partial) 3,229 (estimate)	17,130 (partial) 18,705 (estimate)

14 Awards and Recognition[99]

Type of Award or Recognition	# as of 2014	%
Appointed to the editorial board of, or advisor to, a journal or book series	1,756	10
Attracted visiting staff or internships to laboratory	496	3
Awarded membership, or a fellowship, of a learned society	1,448	8
Honorary Degree	18	0
Medal	448	3
NIHR Senior Investigator/Clinical Excellence Award	171	1
Order of Chivalry (eg OBE)	73	0
Other award	12	0
Personally invited as speaker at a conference	7,856	46
Poster/abstract prize	846	5
Prestigious/honorary/advisory position to an external body	2,132	12
Research prize	1,919	11
Total	**17,175**	**100**

Section 4.2 Human Capital (stock)

No.	Metric	Unit	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	TOTAL
		# of new registrations	462	452	488	460	410	411	414	452	387	3,936
		# of active studentships	Not available	Not available	Not available	1,500	1,926	1,773	1,900	1,760	1,642	n/a

New Registrations: Number of MRC-funded PhD students newly registered on the Joint Electronic Submission (Je-S) system by academic year. 2006/07 to 2010/11 figures from the MRC Economic Impact Report 2010/11. Please note that records of MRC studentships on the Je-S database are provided directly by research organisations funded by MRC studentship programmes. These including DTPs and CASE PhD studentships, but may not include all intramural and centre studentships.

Active Studentships: The total number of live MRC-funded PhD studentships, including CRTFs, as at March 2015 was 1,642. These are broken down below by funding mechanism, showing the number and proportion of each (see table below). Further details can be found in the narrative in section 4.2 of main body of report.

15 Number of PhD Students Supported

Funding mechanism	# live at March 2015	%
Doctoral Training Partnership	826	50.3
MRC Intramural Students	343	20.9
Capacity Building Students	15	0.9
Clinical Research Training Fellowship (CRTF)	154	9.4
MRC Centre Studentships	220	13.4
Industrial Case Studentships	84	5.1
Total	**1,642**	**100**

16 Number of Masters Students Supported — See narrative in section 4.2 of main body of report.

No.	Metric	
17	Finishing Rates	Records of MRC studentships on the Joint Electronic Submission (Je-S) database are provided directly by research organisations funded by MRC studentship programmes. These including Advance Course Masters, DTPs and CASE PhD studentships, but do not include intramural studentships. Finishing rates are displayed as a percentage of the total studentships with completed award data. Registration Year runs from 1st of October to 30th of September and is reported on after five years. Note that duration of studentships varies therefore assessment of whether a student has submitted 'Within/After Submission Period' is dependent on comparisons with expected submission date and actual submission date. Also note the guidance for on-time submission for most studentships changed in 2010/11 from 'within a year of funding end' to 'within six months of funding end'. Data for registration years 2004 to 2006 was collected via the Je-S Submission survey 2011. Only complete studentship data were included and criteria for collection may not match the description above. Data for registration years 2007/2008 and 2009 was collected via the JeS submission survey 2013 and 2014 respectively. A significant proportion of studentships remains on the system without a definitive submission/award date, and are therefore classified as "unknown". As a result, percentages displayed here for unknown (*) are of all students on JeS for that registration year.

Registration Year	2004/05		2005/06		2006/07		2007/08		2008/09		2009/10	
(Reporting Year)	(2008/09)		(2009/10)		2006/07		(2011/12)		(2012/13)		(2013/14)	
	#	%	#	%	#	%	#	%	#	%	#	%
Within Submission Period	326	91.6	394	90.8	286	89.4	94	77.7	225	92.2	223	92.5
After Submission Period	9	2.5	4	0.9	0	0.0	18	14.9	3	1.2	3	1.2
Delayed Submission	6	1.7	9	2.1	25	7.8	0	0.0	0	0.0	9	3.7
Student will not Submit	15	4.2	27	6.2	9	2.8	9	7.4	16	6.6	6	2.5
Total with Award Data	356	100	434	100	320	100	121	100	244	100	241	100
Unknown							173	58.8*	240	49.6*	131	35.2*
Total (All Studentships)							294		484		372	

No.	Metric	Unit	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Notes
18	Student funding / training schemes	£m	3.2	2.5	3.1	3.4	3.5	3.0	2.6	Industry case studentships – funding by academic year.

Section 4.3 Knowledge Transfer and Exchange

No	Metric	
19	KE Spend	See narrative in section 4.3.
20	KE Programmes	Numbers of awards and total commitment values for some of the MRC translational schemes.

Scheme	2008/09		2009/10		2010/11		2011/12		2012/13		2013/14		2014/15	
	#	£m	#	£m	#	£m	#	£m	#	£m	#	£m	#	£m
Methodology Research Programme	18	6.1	23	7.4	9	3.5	14	5.0	11	3.5	8	3.9	15	4.8
Regenerative Medicine Research Committee[100]	12	6.4	13	7.3	10	7.6	7	4.5	6	3.9	4	3.2	4	3.4
Developmental Pathway Funding Scheme (DPFS)[101]	15	6.4	17	8.7	19	12.0	18	11.9	10	6.4	-	-	-	-
Developmental Clinical Studies (DCS)	-	-	3	5.3	10	13.7	20	22.3	-	-	-	-	-	-
Biomedical Catalyst Fund[102]	-	-	-	-	-	-	-	-	41	30.7	51	40.2	51	40.7
Stratified Medicine Initiative	-	-	-	-	5	12.0	1	6.0	4	15.9	2	9.0	4	13.7

Section 4.4a Intellectual Property Activity (MRCT managed)

No	Metric	Unit	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	TOTAL	Notes
21a	Patents applications (MRCT managed)	#	20	25	12	12	20	11	9	109	This data is collected through MRCT and therefore only represents MRC's intramural programmes. Income from IP includes licence income and receipts from sales of shares in MRC companies.
22a	Patents granted (MRCT managed)	#	24	29	32	27	38	32	42	224	
23b	Spinouts/new businesses created (MRCT managed)	#	0	0	2	0	0	0	0	2	
24	Income from IP activity (MRCT managed)	£m	64.19	66.17	61.69	78.98	91.72	85.4	94.9	543.1	

Section 4.4b Intellectual Property Activity (researchfish® data)

No	Metric	Unit	unknown	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
21b	Numbers of patents (researchfish® data)												
	Not licensed	#	56	9	39	101	138	143	71	67	54	25	703
	Licensed	#	38	12	26	19	38	39	23	27	18	6	246
	Commercial in confidence	#	8	4	8	8	13	26	24	25	10	6	132
	Total	#	102	25	73	128	189	208	118	119	82	37	1,081

No	Metric	Unit	Pre 2006	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
23b	Spinouts/new businesses created (researchfish® data)	#	17	5	3	11	5	9	12	10	9	7	88

MRC funding has contributed to the set up or growth of 88 companies, 71 of which have been formed since 2006. It is estimated that these companies represent at least 100 to 300 new highly skilled jobs in the UK.

Data was collected based on company formation date following award start date, the de-duplicated based on company name (not ID#) for a unique count. Note that since the last Economic Impact Report these data has been fully cleaned to remove business connections with constitute collaborations, not spinouts/new businesses. Therefore data displayed here is not directly comparable with previous reports. Data consolidated and corrected for duplications as of researchfish® SQL database extraction 29/07/15.

Section 5.1 Human Capital (flow)

No	Metric
25	Destination of leavers

The following data show the first destination of PhD students qualifying or completing their courses between 1st of August 2007 and 31st of July 2014.Please note that this is an incomplete return and does not cover the total number of students funded by the MRC.

Taken from DLHE (Destination of Leavers from Higher Education) data 2014 which collects data on students who completed their courses between 1st of August 2013 and 31st of July 2014. The DLHE 2015 (ie data on students completing in 2014/15) is not yet available and will therefore be included in next year's Economic Impact Report (2015/16). HESA categories are grouped by University, Wider Public Sector, Private Sector, Other/Unknown or Unemployed. MRC does not have separate data to report against Third Sector (charitable) employment.

Group / HESA Category	2007/08		2008/09		2009/10		2010/11		2011/12		2012/13		2013/14	
University	86	56%	132	53%	159	54%	153	54%	163	50%	193	58%	162	51%
Further study, training or research	12	8%	19	8%	17	6%	9	3%	22	7%	25	7%	18	6%
Higher education (academic)	3	2%	9	4%	7	2%	15	5%	6	2%	11	3%	6	2%
Higher education (mainly research)	70	46%	100	40%	126	43%	125	44%	133	41%	154	46%	134	42%
Higher education (other)	1	1%	4	2%	9	3%	4	1%	2	1%	3	1%	4	1%
Wider Public Sector	15	10%	24	10%	32	11%	18	6%	34	11%	38	11%	28	9%
Government & public sector (not research related)	9	6%	19	8%	26	9%	14	5%	0	-	33	10%	23	7%
Government & public sector (research related)	6	4%	5	2%	6	2%	4	1%	34	11%	5	1%	5	2%
Private Sector	14	9%	26	11%	18	6%	31	11%	27	8%	37	11%	44	14%
Industry & commerce (research related)	3	2%	3	1%	2	1%	4	1%	5	2%	4	1%	4	1%
Industry & commerce (not research related)	11	7%	23	9%	16	5%	27	9%	22	7%	33	10%	40	13%
Unknown or Other	30	20%	42	17%	62	21%	58	20%	79	24%	46	14%	70	22%
R & D sector unknown	25	16%	27	11%	49	17%	39	14%	43	13%	39	12%	42	13%
Not known or not reported	1	1%	12	5%	9	3%	11	4%	31	10%	15	4%	19	6%
Other employment	0	-	1	<1%	1	<1%	2	1%	0	-	0	-	2	1%
School (education other)	1	1%	0	-	0	-	3	1%	0	-	3	1%	2	1%
School (teaching or teacher training)	1	1%	1	<1%	2	1%	1	<1%	1	<1%	0	-	0	-
Self-employed, voluntary and unpaid work	2	1%	1	<1%	1	<1%	2	1%	4	1%	2	1%	5	2%
Unemployed	8	5%	23	9%	21	7%	25	9%	20	6%	21	6%	16	5%
Total	**153**		**247**		**292**		**285**		**323**		**335**		**363**	

No	Metric	Unit	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	TOTAL
		#	46	34	34	33	35	30	212

Numbers of Industrial CASE awards over the last four years, these are awarded in partnership with industry or policy making bodies. In 2013/14 MRC awarded 10 (out of 30) industrial CASE studentships to SMEs. The industrial partners for all 30 awards in 2013/14 are listed below:

Company	SME	Awarded
AstraZeneca	N	2
Bio Products Laboratory Ltd.	N	1
BioMoti Ltd.	Y	1
Boston Scientific	N	1
Critical Pharmaceuticals Ltd.	Y	1
Defence Science and Technology Laboratory (DSTL)	N	1
Domainex Ltd.	Y	1
Eisai Ltd.	N	3
Eli Lilly and Company Ltd	N	2
Essen BioScience	Y	1
GlaxoSmithKline	N	4
Immunocore Ltd.	Y	1
MedImmune	N	1
Medivir	Y	1
Nikon UK (Instrument Division)	N	1
Novartis Pharmaceuticals UK Ltd.	N	3
Optos PLC	N	1
Oxford Optronix	Y	1
Pharmidex Pharmaceutical Services Ltd.	Y	1
Redx Oncology Ltd.	Y	1
Touchlight Genetics Ltd.	Y	1
Total		**30**

26 Placements in user organisations

Section 5.2 Public Policy

No	Metric	Unit	No Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
		#	21	287	255	440	520	565	653	635	660	416 (partial) 690 (estimate)	4,452 (partial) 4,726 (estimate)
27	Instances of Influence on Policy and Practice[103]												

Policy	# as of 2014	%
Influenced training of practitioners or researchers	946	21
Citation in clinical guidelines	472	11
Citation in clinical reviews	96	2
Citation in other policy documents	326	7
Citation in systematic reviews	109	3
Gave evidence to a government review	246	6
Implementation circular/rapid advice/letter to eg Ministry of Health	72	2
Membership of a guidance committee	547	12
Other/Unknown	1	<0.1
Participation in an advisory committee	1,226	29
Participation in a national consultation	378	9
Total	4,419	100

28	Instances of influence	Influences on policy setting processes, 3,415 reports between 2006 and 2014.
29	Value/changes induced	Citations in key policy documents, 1,003 reports between 2006 and 2014.

Section 5.3 Public Engagement

No	Metric	
30	Public Engagement Activities	Below is a summary of the data by type of dissemination activity reported between 2006 and 2014. To reduce the burden on researchers they are advised to report just one of any type of activity within any given year therefore these figures are an underestimation of actual activity.

Type	# as of 2014	%
A formal working group, expert panel or similar	2,716	9
A magazine, newsletter or online publication	3,559	12
A press release, press conference or response to a media enquiry.	2,347	8
A talk or presentation	11,009	37
Participation in an activity, workshop or similar	4,864	16
Participation in an open day or visit at my research institution	2,192	7
Scientific meeting (conference/symposium etc.)*	3,388	11
Total	30,075	100

End Notes

1. The MRC Economic Impact Reports can be found by using the search option or tag link "economic impact" at: **http://www.mrc.ac.uk/news-events/publications/**
2. researchfish® is a registered trademark of researchfish Limited: **https://www.researchfish.com/**
3. Research Councils UK Gateway to Research. **http://gtr.rcuk.ac.uk/**
4. MRC Annual Report and Accounts 2014/15: **http://www.mrc.ac.uk/publications/browse/annual-report-and-accounts-2014-15/**
5. MRC Outputs, outcomes and impact of MRC research 2014/15: **http://www.mrc.ac.uk/successes/outputs-report/**
6. **http://www.mrc.ac.uk/publications/browse/strategic-plan-2014-19/**
7. **http://www.mrc.ac.uk/publications/browse/delivery-plan-201112-201415/**
8. **http://www.mrc.ac.uk/publications/browse/delivery-plan-2015-16/**
9. **www.mrc.ac.uk/news-events/publications/delivery-plan-reporting-framework-2014-15/**
10. **http://www.mrc.ac.uk/publications/browse/annual-report-and-accounts-2014-15/**
11. **http://www.mrc.ac.uk/successes/outputs-report/ https://www.mrc.ac.uk/successes/outputs-report/**
12. For further details on the definition and uses of NCI statistics, see the publication outputs section on page 12.
13. 1,488 as at March 2015, plus a further 154 clinical research training fellowships.
14. In 2013/14 MRC provided substantial additional funding to support the construction of The Francis Crick Institute. The 2013/14 in-year funding under the joint venture agreement was £114.4m, with further capital support of £39.3m. In 2014/15 this funding was £38.0m and £1.3m respectively.
15. Studentship data correct as of March 2015.
16. MRC Annual Report and Accounts 2014/15: **https://www.mrc.ac.uk/publications/browse/annual-report-and-accounts-2014-15/**
17. **http://www.mrc.ac.uk/skills-careers/Fellowships/**
18. Clinical Research Training Fellowships (CRTFs) support clinicians undertake a higher degree (PhD or MD). They are counted under fellowships in the MRC Annual Report training award totals quoted here, but are classified as studentships in the context of PhD programmes elsewhere in this report.
19. More information on researchfish® Ltd. can be found at: **www.researchfish.com** and **http://www.mrc.ac.uk/funding/guidance-for-mrc-award-holders/researchfish/**
20. As at September 2015: **https://www.researchfish.com/ourmembers**
21. MRC's last annual data gathering period (DGP) was Oct/Nov 2014. The next DGP is scheduled for Feb/Mar 2016.
22. MRC Official researchfish® Sample Data Report 2014: **http://www.mrc.ac.uk/documents/pdf/official-mrc-researchfish-report-sample-data-21-07-15/**
23. Principally MRC Annual Reports and Outputs Reports **http://www.mrc.ac.uk/news-events/publications/outputs-outcomes-and-impact-of-mrc-research-2013-14/**
24. In particular, in a slight modification to earlier analyses, outputs dated before award start dates are not included in the figures reported.
25. Normalised citation impact data and analysis: Evidence, Thomson Reuters UK.
26. The normalised citation impact scores were taken at the end of 2014 for MRC publications published between 2006 and 2013 (as reported in researchfish®).
27. MRC (2015) *Official MRC researchfish® Report Sample Data Report*. Accessed 20/11/2015.: **http://www.mrc.ac.uk/documents/pdf/official-mrc-researchfish-report-sample-data-21-07-15/**
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53. For example, Excellence in Research for Australia: **http://www.arc.gov.au/excellence-research-australia**
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56. Expenditure on CRTFs is counted under fellowships in the MRC Annual Report, and features in this report on page 9. However as a PhD training award CRTFs are classified as studentships in the context of PhD programmes here.
57. Data collected from the Je-S student data portal (CRTFs collected by MRC in house system), information on students at MRC centres has been collected directly from the centres via email correspondence.
58. More information on MRC's DTPs can be found on the MRC website: **http://www.mrc.ac.uk/skills-careers/studentships/how-we-fund-studentships/doctoral-training-partnerships-dtps/**
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90. As used in MRC Annual Report and other MRC publications.
91. This definition of leverage is used by BIS to allow comparative assessments between the research councils.
92. Other income includes sales of laboratory and library services, as well as proceeds from the sales of radioisotopes etc.
93. Under "commercial activities" in the Annual Report. Income from IP includes licence income and receipts from sales of shares in MRC companies.
94. Annual Report financial statement section 13 is £71.1m, but £7.2m is intramural (see section 2). £63.9m is the extramural value only.
95. From Thompson-Reuters data, via researchfish®. Values for metrics 7-10 are based upon paper outputs labelled as 'review' or 'article' under data type heading, extracted on 6th of October 2014.
96. Previous reports have segregated publications by articles (8a) and reviews (8b). However reporting in researchfish® has changed since 2013 and both articles and reviews are now reported together.
97. Data obtained from researchfish® SQL database extraction on 12/08/15.
98. Data obtained from researchfish® SQL database extraction on 12/08/15
99. Data obtained from researchfish® SQL database extraction on 12/08/15.
100. Regenerative Medicine Research Committee was previously the Translational Stem Cell Research Committee (TSCRC). Drawing on the experience and expertise of the MRC's TSCRC, the MRC has established the Regenerative Medicine Research Committee, to provide support for high quality proposals aiming to develop regenerative medicine therapies to improve human health.
101. In early 2012/13 the DPFS and DCS schemes were merged into one scheme. The revised DPFS provided one round of funding in May 2012.
102. Biomedical Catalyst (BMC) commitment includes awards made through the DPFS Panel and Major Awards Committee from Sept 2012 onwards, academic costs on Early and Late stage business-led BMC awards and awards made under the Confidence In Concept scheme. 2014/15 data includes both BCF and DPFS funding.
103. Data obtained from researchfish® SQL database extraction on 12/08/15.

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ISBN: 978-0-9037302-1-1