MRC Medical Research Council

THE MEDICAL RESEARCH COUNCIL

Economic Impact Report 2011/12

Contents

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 reports are available on the MRC website[1], and the most recent report for each research council is available on the RCUK website[2].

The research councils have worked closely with BIS with the aim of streamlining the metrics that are presented in this report. The total number of metrics presented has decreased each year and those that remain are targeted at specific aspects of research council impact. The aim has also been to make reporting across the councils more consistent and to provide more informative and robust metrics.

The list of metrics agreed between BIS and all 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. The additional metrics for the MRC are noted in Annex 1.

The *Economic Impact Report* now also contains case studies, which would previously have been included in the Economic Impact Baseline Report[3]. These two publications have been merged.

This report should be read in conjunction with the *MRC Annual Report and Accounts 2011/12* and the *MRC Annual Review 2011/12*[4], which provide a comprehensive summary of achievements over the period.

The MRC *Economic Impact Report* includes data for 2008/09, 2009/10, 2010/11 and 2011/12 where possible.

[1] The MRC Economic Impact Reports can be found at:
http://www.mrc.ac.uk/Newspublications/Publications/EIRF/index.htm
[2] RCUK Economic Impact Reporting Frameworks can be found at:
http://www.rcuk.ac.uk/kei/maximising/MeasuringImpact/Pages/EIRFs.aspx
[3] The Economic Impact Baseline report for 2009/10 was called *Impact of MRC Research* and can be found at:
http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC007392
[4] The MRC Annual Report and Accounts and Annual Review can be found at:
http://www.mrc.ac.uk/Newspublications/Publications/index.htm

2.0 Summary and highlights

At the heart of the MRC's mission is to improve human health through world-class medical research. To achieve this, we support research across the biomedical spectrum, from fundamental laboratory-based science to clinical trials, in all major disease areas. The organisation works closely with key stakeholders and other research funders in the UK and internationally to deliver our mission, prioritising research that is likely to make a real difference to clinical practice and the health of the population. MRC stakeholders include the UK's health departments and other government departments and agencies, the six other research councils, industry, the academic and charity sectors, and the public.

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; and
- promote dialogue with the public about medical research.

In June 2009 the MRC published its Strategic Plan for 2009-2014 *Research Changes Lives* which sets out the framework by which the MRC aims to support medical research that increases the pace of transition to better health. The mid-term progress report for the strategic plan published recently[5] gives an overview of MRC activities and the outcomes of MRC research with the aim of informing discussions on research priorities for the future. It is the first time that the MRC has measured progress against strategic objectives in this way, and this evaluation has been supported by the systematic collection of output data via MRC e-Val,[6] a highly successful process for capturing feedback from all research groups funded by the MRC since 2006. Significant progress has been demonstrated against most (approximately 70 per cent) of the specific objectives in *Research Changes Lives*, while in other areas there is evidence that delivery is underway and advances are expected in the second half of the strategic plan period.

The MRC has also contributed to a major new analysis of UK Health Research, co-ordinated by the UKCRC[7]. This analysis has shown that additional funding received by the public funders of medical research since the 2007 spending review has been allocated to areas of under-investment. In particular, new support for translational research is building research capacity in this area, addressing the recommendations of the Government's review of health research published in 2006[8]. The analysis also highlights for the first time the overall volume of private, charitable and public sector spend in the UK on health-relevant research, and the high degree of complementarity between these funding streams.

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[5] Mid-term report on progress against objectives in the MRC Strategic Plan *Research Changes Lives*http://www.rclprogress.mrc.ac.uk/

[6]http://www.mrc.ac.uk/Achievementsimpact/Outputsoutcomes/e-Val/index.htm

[7] The UKCRC Health Research Analysis 2012 http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC008927

[8]*A review of UK health research funding* (HM Treasury, 2006) http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/cooksey_review_index.htm

In a unique partnership between the MRC, major charitable funders and London universities we are on track to establishing the Francis Crick Institute[9], a major new national biomedical research institute that will play a key role in creating the foundation of knowledge on which this century's improvements in health will be based.

MRC research generates world-leading knowledge

A widely used indicator of the quality of research is the extent to which others cite publications arising from the work. The MRC e-Val dataset allows the MRC to easily analyse publication output across its portfolio. Analysis of more than 26,000 peer-reviewed papers produced by MRC-funded research groups between 2006 and 2010 has found that these papers have more than twice the world average citation impact. UK papers in biological sciences and clinical or health-related disciplines typically have a citation impact of 1.5 times the world average[10]. This excellence is the result of effective and efficient selection procedures, combined with well-judged strategic investments to develop newer areas. The MRC will seek to maintain the impact of its work at this world-leading level.

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

Between 2006 and 2011 MRC research groups reported 6,500 collaborations involving 8,700 partners, corresponding to almost 3,000 unique organisations across 95 countries. Collaborations might be evidenced by (but not limited to) outputs such as exchanging expertise, materials, access to facilities, co-authorship of papers, or obtaining joint funding.

MRC-funded research groups received additional funding from more than 800 different organisations across 40 countries. Non-MRC funding obtained by MRC supported research groups since 2006 has a total lifetime value of £2.9bn, and approximately £300m of this is spent each year. Almost a third of this further funding is obtained from outside of the UK or the private sector, helping to grow the UK science base.

The MRC continues to strengthen its interactions with industry, transforming the support of private sector-academic collaboration in the UK.

We include new analysis in this report which highlights the extent to which MRC-funded research groups co-author publications with industry. We show that the extent of MRC-industry co-authorship of these papers has increased from around 5 per cent in 2006 to almost 7 per cent in 2011. This demonstrates the impact of MRC policies to encourage academic-industry interactions feeding through to front-line UK science, and we expect this trend to continue, particularly as we work closely with the Technology Strategy Board to implement commitments under the Biomedical Catalyst[11].

Strengthening the way we work with industry for the benefit of UK science is a key goal in the MRC strategic plan and is directly relevant to the Government's

[9] http://www.crick.ac.uk/
[10] Data sourced from Thompson Reuters
[11] MRC/TSB press release (August 2012) "First awards made through the Biomedical Catalyst" http://www.innovateuk.org/_assets/bmc_2august.pdf

Strategy for UK Life Sciences[12]. A partnership established with the Association of the British Pharmaceutical Industry (ABPI) in 2009 has been one driver for a transformational relationship with industry. The £9.5m MRC-ABPI Inflammation and Immunology initiative represents the first time an MRC initiative has been co-designed with industry and is a new way of working that brings together the best of clinical science, well-characterised cohort studies and industry partners. Two disease specific consortia were established tackling Chronic Obstructive Pulmonary Disease (COPD) and Rheumatoid Arthritis. The closer and more productive interaction with industry in this successful pilot programme has shaped the stratified medicine initiative, a £60m four-year MRC initiative started in 2011 which has leveraged additional support from the Technology Strategy Board, Cancer Research UK and others to accelerate the adoption of stratified medicine in the UK[13]. In total it is estimated that these partners will invest around £200m in the Stratified Medicine Innovation Platform over five years.

The MRC/AstraZeneca Mechanisms of disease call[14] is another example of a novel outcome from such discussions. In a world-first this initiative launched by the MRC in 2011 has made available 22 AstraZeneca compounds to the academic research community to investigate disease mechanisms and determine whether these can be used for previously unknown indications. In May 2012 the U.S. government said it would follow a similar approach to work with large pharmaceutical companies to try to find new uses for once-promising drugs that have been cast aside by the industry[15]. The collaboration between the National Institutes of Health, Pfizer Inc., Eli Lilly & Co. and AstraZeneca Plc. aims to match abandoned drugs with researchers from universities, hospitals and the NIH. The MRC scheme has already received 100 research proposals from 37 institutions and decisions made on the first awards in October 2012.

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

Approximately 10 per cent of MRC-funded research groups reported that their work involves, or has led to, the development of a new product or intervention. This might involve for example the development of new drugs, medical devices, research techniques or equipment. We are following the progress of more than 500 of these translational projects for which details have been reported via MRC e-Val.

Of these 500 projects, 70 have led to new products being launched onto the market since 2006, showing the real potential of medical research innovation. However, around 400 MRC prospects are currently on the wrong side of the "valley of death"[16]. Many of these projects are being actively translated with MRC support via the Developmental Pathway Funding Scheme, Developmental Clinical Studies or similar, but successfully taking these developments into application will

[12] http://www.bis.gov.uk/assets/biscore/innovation/docs/s/11-1429-strategy-for-uk-life-sciences

[13] Stratified Medicine in the UK Vision and Roadmap http://www.innovateuk.org/_assets/pdf/publications/roadmap_stratifiedmedintheuk%20_final.pdf

[14] http://www.mrc.ac.uk/Fundingopportunities/Calls/MoD/MRC008389

[15] "NIH Industry to seek uses for abandoned drugs" (Wall Street Journal, 2012) http://online.wsj.com/article/SB10001424052702303877604577382392599422600.html?KEYWORDS=%22medical+research+council%22

[16] There is a current House of Commons Science and Technology Select Committee enquiry into this issue "Bridging the "valley of death": improving the commercialisation of research"

require significant additional investment and appropriate commercial partnership. If charitable funding and university support for medical research is taken into account, then the number of "investable opportunities" in the UK academic medical research sector could easily be two or three times higher than the portfolio tracked by the MRC. This indicates a huge untapped resource for economic growth and potential for improvements in healthcare.

One area already identified as holding the promise of revolutionising patient care is regenerative medicine[17]. The MRC's long-term and strategic investment in a portfolio of high quality research and essential infrastructure has helped put the UK in a strong position to capitalise on discoveries in this field. Examples of these investments include:

- £3m to derive clinical grade stem cell lines led to the world's first clinical grade, xeno-free stem cell line being deposited in the UK Stem Cell Bank.

- The MRC's Translational Stem Cell Research Committee has established a portfolio of six early phase clinical trials of adult stem cell therapies and are pursuing the critical developmental work to support human embryonic stem cell therapies.

- MRC-supported research has demonstrated evidence of functional recovery of damage in the eye through cell transplantation, providing encouragement for the development of stem cell therapies for debilitating eye conditions[18]. The first UK exploratory clinical studies using UK-derived human embryonic stem cells to treat age-related macular degeneration are expected to start soon.

The MRC has an unrivalled track record in commercialising its research. Since 1998 MRC Technology has generated £650m for re-investment in medical research (£210m in the last three years alone). MRC researchers have reported more than 400 published patents arising from their work since 2006. Around 30 per cent of these discoveries have been licensed to others and can reasonably be expected to have potential for generating new income. MRC e-Val also allows the MRC to track links with 86 companies which were established or have grown as a result of MRC research, 49 of these were established since 2006, and in total these companies employ around 450 people.

Recent examples of potentially transformative developments realised in 2011/12include:

- MRC spin out Heptares Therapeutics announced the first structure of a family B GPCR protein[19] solved entirely in house using techniques pioneered at the MRC Laboratory of Molecular Biology. The structure-based drug design used by Heptares creates new medicines targeting previously undruggable or challenging GPCRs, a superfamily of receptors linked to many diseases. Heptares, established in 2007, has raised £30m

[17] In 2012 the MRC, BBSRC, EPSRC, ESRC and TSB published "A Strategy for UK Regenerative Medicine" http://www.mrc.ac.uk/consumption/idcplg?IdcService=GET_FILE&dID=35196&dDocName=MRC008534&allowInterrupt=1

[18] Restoration of vision after transplantation of photoreceptors (2012), RA Pearson et al. *Nature* 485,99–103 doi:10.1038/nature10997

[19] Heptares Solves First Family B GPCR Structures http://www.heptares.com/news/65/74/Heptares-Solves-First-Family-B-GPCR-Structure.html

of investment, and forged partnerships with Novartis, Shire, AstraZeneca, MedImmune and Takeda estimated to be worth potentially £450m. The company now employs 70 staff.

- Human Genome Sciences/GlaxoSmithKline received FDA approval for Benlysta™ the first new therapy for Lupus in 50 years. Development of this monoclonal antibody relied upon MRC-patented technology. Benlysta™ is in use in the US (where it is projected to address a market valued at $1.4bn pa). NICE is to re-consider recommending the treatment in the UK[20].

- Imanova Ltd. was launched[21] in October 2011,a unique £43m joint venture with three London universities and significant engagement from GlaxoSmithKline. Imanova will deliver cutting-edge Positron Emission Tomography (PET) imaging technologies to researchers in the UK and promote new ways of working between academic and commercial researchers

- MRC-funded research led in part to the development of protein pores as nanoreactors for observing chemistry at the single-molecule level. The work contributed to an Oxford spin-out company established in 2005, now called Oxford Nanopore Technologies (ONT), with a focus on single molecule sequencing. ONT has grown to employ 95 staff and in 2012 announced it would market a new DNA sequencer the size of a USB memory stick[22]. The technology from Oxford Nanopore Technologies is being seen as transformative[23] in a multi-billion dollar market.

- The largest UK academic/private sector collaboration, the Division of Signal Transduction Therapy (DSTT), was renewed in 2012, bringing the total amount invested in DSTT since 1998 to £50m. The DSTT is funded by six of the world's largest pharmaceutical companies[24] and focuses on speeding up the development of drugs aimed at treating major diseases, including cancer, hypertension and lupus, by targeting proteins in the body's ubiquitin system and types of enzymes called kinases. The new funding secures 50 posts in Dundee.

[20] http://www.reuters.com/article/2012/09/07/glaxosmithkline-lupus-idUSL6E8K759L20120907
[21] http://www.imanova.co.uk/
[22] Company Unveils DNA Sequencing Device Meant to Be Portable, Disposable and Cheap (New York Times, February 2012) http://www.nytimes.com/2012/02/18/health/oxford-nanopore-unveils-tiny-dna-sequencing-device.html?_r=1
[23] MinION™ a miniaturised sensing instrument (Oxford Nanopore Technologies website) http://www.nanoporetech.com/technology/minion-a-miniaturised-sensing-instrument
[24] The DSTT secures a further £14.4m from AstraZeneca, GlaxoSmithKline, BoehringerIngelheim, Janssen Pharmaceutica, Merck-Serono and Pfizer (Scotsman 2012) http://www.scotsman.com/business/industry/pledges-to-drugs-discovery-centre-take-investment-to-50m-level-1-2292598

3.0 Inputs: investment in the research base

3.1 Income and expenditure

In 2011/12 the MRC's gross research expenditure was £759.4m. This is broken down in more detail at Annex 2 in Section 3.1 Income and expenditure.

3.2 Human capital (input)

The MRC trains and develops the next generation of research leaders by supporting outstanding individuals at crucial points in their research careers. We strive to address the nation's strategic skills needs, ensuring a world-class killed research base for the UK that can respond to current and future challenges in medical research.

The MRC supports more than 5,700 research staff at all levels, either through direct employment in intramural MRC institutes and units, or funding them through university units, grants and fellowships. Further details are given at Annex 2 in Section3.2 Human capital (input). At the end of March 2012, there were around 400 MRC fellows in higher education institutions and MRC research establishments.

2011/12 was a good year for applications to our New Investigator Research Grants, with 26 awards and a success rate of 28 per cent, compared with 15 and a success rate of 12 per cent in 2010/11. These grants provide flexible support for clinical and non-clinical scientists while they are establishing themselves as independent principal investigators.

The MRC funds a range of fellowship award schemes for both clinical and non-clinical researchers, as well as specific fellowships in strategically important research areas. There is further information on MRC schemes on our website[25] as well as case studies on individuals that the MRC has supported during significant parts of their careers, including one on Dr Matt Cairns who is a Research fellow at the London School of Hygiene and Tropical Medicine[26], and one on Lizzy Day who is an MRC PhD student at the University of Cambridge[27].

[25] http://www.mrc.ac.uk/Fundingopportunities/Studentships/index.htm
[26] http://www.mrc.ac.uk/Achievementsimpact/Profiles/MattCairns/index.htm
[27] http://www.mrc.ac.uk/Achievementsimpact/Profiles/LizzyDay/index.htm

4.0 Outputs: research performance

4.1 Knowledge generation

The data presented here and below on outputs and outcomes was collected through MRC e-Val, the successful MRC online system that collects outputs, outcomes and impacts information from MRC-funded researchers. Data is collected annually during an eight-week data gathering period at which point researchers can add to and/or amend the data held against their awards. This means that the numbers reported here this year will be different to those reported last year as researchers can continue to add outputs retrospectively.

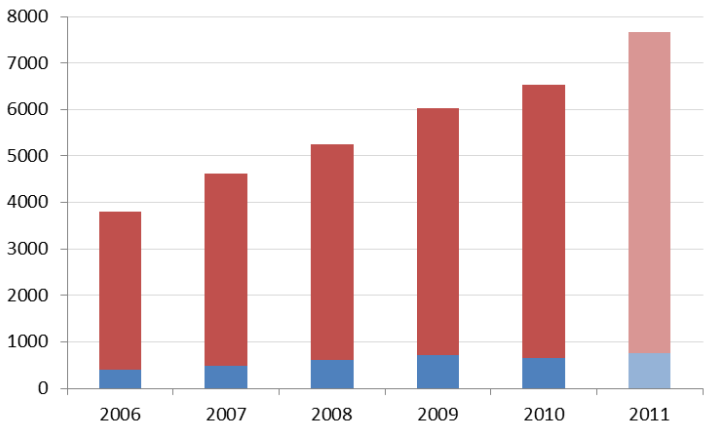
During the data-gathering period at the end of 2011 we obtained 3,841 submitted MRC e-Val returns having sought 3,924, a 98 per cent response. This improves upon the 91.4 per cent response in 2010. For the data collection exercise at the end of 2012 we will use the new federated version of MRC e-Val, Researchfish, which is used across multiple funders[28].

4.1.1 Paper outputs

Publications are one of the most well-known types of research output; they record new knowledge, methods or insights from a synthesis of existing work, and enable these to be used in other research. The citation of publications in further peer-reviewed research articles is often used as a measure of research productivity and 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 called the world average, so an nci of above 1 means that the paper is more cited than expected. A further measure of quality of publications is the number/percentage of articles that are either uncited or conversely those deemed as highly cited (i.e. nci≥4). (Normalised citation impact data and analysis: Evidence, Thomson Reuters UK.)

Number of Grants assessed for reporting	3,841 submitted MRC e-Val returns
Refereed Publications	Numbers of unique publications submitted by MRC-funded researchers via MRC e-Val, by year of publication[29].

[28] Further information about Researchfish can be found at: www.researchfish.com
[29] The data gathering period for MRC e-Val in 2011/12 closed in December 2011. The numbers of unique publications submitted by MRC-funded researchers (both intramural and extramural) in 2011/12 are therefore estimated (partial year numbers for reviews 575, articles 5179).



See Annex 2 Section 4.1 Knowledge Generation, for actual numbers.

Only 14.3 per cent of 2006-2011 MRC papers remain "uncited" in 2011, in contrast to 18.8 per cent of UK biological sciences papers (minus MRC papers), and 22.5 per cent of UK medically-related papers (minus MRC papers).

Most MRC papers are more highly cited than the world average and the average nci for the MRC is 2.16, more than twice the world average. UK research published for the same time frame in 'Clinical/Health & medically related fields' had an average nci of 1.39.

14.3 per cent of MRC papers are more than or equal to four times the world average, in contrast to 8.5 per cent of UK biological sciences papers (minus MRC papers), and 7.7 per cent of UK medically-related papers (minus MRC papers).

A report, *International Comparative Performance of the UK Research Base: 2011*[30], was produced by Elsevier for BIS**.** The 2011 report is the first of a new biennial enquiry into the international standing of UK research.

This report showed that the proportion of UK researchers that publish articles with non-UK researchers is high and rising, reaching 46 per cent in 2010. This proportion was shown to be far higher than in most other research-intensive nations. As can be seen above, the MRC data shows that a similar proportion of MRC-funded publications (48 per cent) are co-authored internationally.

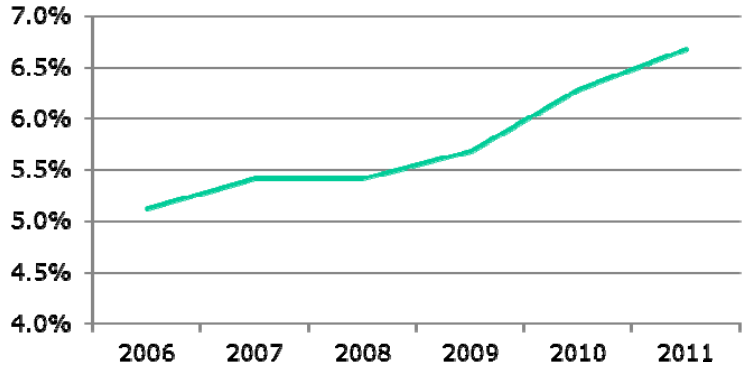
The comparative analysis report also showed that the UK's proportion of articles that are co-authored by researchers in both academic and corporate sectors is relatively low (1.3 per cent) compared to other major countries. However, the MRC data shows that 8.5 per cent of MRC-funded publications are co-authored with at least one author from industry, so this is significantly higher than generally across the UK research base.

If the overall number of authors identified as from the private sector is plotted as a proportion of all authors on MRC funded, peer-reviewed papers, by year, then we see that this has increased from around 5 per cent in 2006 to almost 7 per cent in 2011. We expect this to continue to increase given that our 2011 data is

[30] http://www.bis.gov.uk/policies/science/science-innovation-analysis/uk-research-base

partial. We suggest that this increase is due in part to a number of MRC initiatives to encourage collaboration with industry.

% private sector authors on MRC funded papers by year



Papers published in 2011 already exhibiting high citation impact

In the bibliometric analysis above we included papers entered into the Thompson Reuters database between the years 2006 and 2011 with citation counts taken at the end of 2012, in order that all papers had at least one year to accumulate citations. There are papers, however, published after 1st April 2011 that have already rapidly been cited. Some examples of these include:

Publication	Summary	nci
The diagnosis of mild cognitive impairment due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease.(Albert et al,**Alzheimers Dement**. 2011 May;7(3):270-9. Epub 2011 Apr 21. PMID 21514249)	A paper to publish the findings of a working group tasked with developing criteria for the symptomatic pre-dementia phase of Alzheimer's disease (AD). The working group developed the following two sets of criteria: (1) core clinical criteria that could be used by healthcare providers without access to advanced imaging techniques or cerebrospinal fluid analysis, and (2) research criteria that could be used in clinical research settings, including clinical trials. The publication is co-authored with an MRC-funded researcher based at University College London.	76
The effects of lowering LDL cholesterol with simvastatin plus ezetimibe in patients with chronic kidney disease (Study of Heart and Renal Protection): a randomised placebo-controlled trial. (Baigent et al, **Lancet**. 2011 Jun 25;377(9784):2181-92. Epub 2011 Jun 12. PMID 21663949)	A highly collaborative paper (2,079 collaborators), reporting the outcomes of a randomised double blind trial assessing the effect of lowering LDL cholesterol in patients with chronic kidney disease using simvastatin plus ezetimibe, which found that specific daily amounts of the drugs safely reduced the incidence of major atherosclerotic events in a wide range of patients with advanced chronic kidney disease. The first author on this paper is an MRC-funded researcher at the MRC Clinical Trial	62

	Service Unit.	
Common variants at MS4A4/MS4A6E, CD2AP, CD33 and EPHA1 are associated with late-onset Alzheimer's disease. (Naj et al, **Nature Genetics**, 2011, 43(5):436-441. PMID 21460841)	The Alzheimer's Disease Genetics Consortium (ADGC) performed a genome-wide association study (GWAS) of late-onset Alzheimer's disease (LOAD) using a three-stage design consisting of a discovery stage (stage 1) and two replication stages (stages 2 and 3). Both joint and meta-analysis analysis approaches were used. The paper reports identifying several LOAD risk loci, which will significantly aid the understanding of the disease. This publication was co-authored by an MRC-funded researcher at the University of Cambridge.	29
Mortality after fluid bolus in African children with severe infection. (Maitland et al**, The New England Journal of Medicine**, 2011, 364(26):2483-2495, PMID 21615299)	The role of fluid resuscitation in the treatment of children with shock and life-threatening infections was not previously established. This research found that fluid boluses significantly increased 48-hour mortality in critically ill children with impaired perfusion in these resource-limited settings in Africa. The first author on this paper is an MRC-funded researcher at Imperial College London.	25

Non-paper outputs

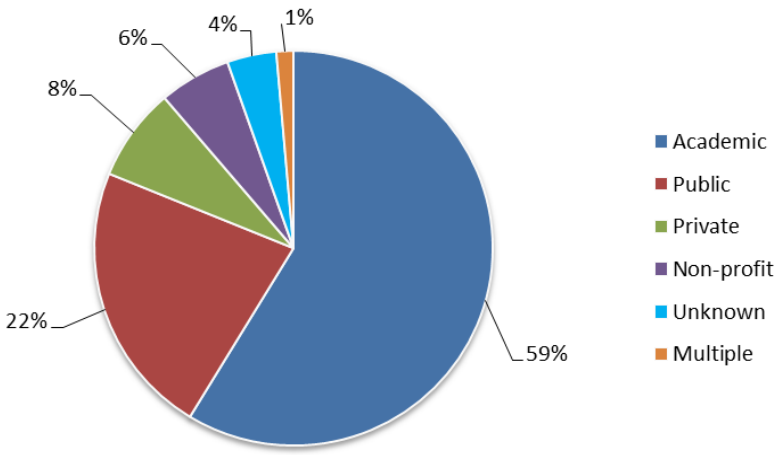
The following data on outputs, outcomes and impacts that have arisen either wholly or partially from MRC-funded research were all reported through MRC e-Val.

4.1.2 Collaborations

A total of 10,871 collaborations were reported in total between 2006 and 2011, across 2,380-MRC funded awards. The data collected includes the approximate start date and whether these collaborations were still active, and 8,545 (79 per cent) were still active in 2011.

The researchers report the collaborating organisations so that the information can be split up by sector.

The chart below shows the percentage of collaborations that have reported at least one partner from the relevant sector.



See Annex 2 Section 4.1 Knowledge generation for actual numbers.

Examples of excellence through collaboration:

MOSAIC – Improving treatments and preparedness for influenza and other respiratory diseases

The MRC, the Wellcome Trust, the Department of Health and other stakeholders convened meetings of the clinical research community (in May 2009) to identify and develop new or enhanced research responses to the H1N1 pandemic. Three key studies were supported through a fast track procedure which brought together key research teams to get new research underway within the pandemic[31].

One of these studies was the **Mechanism of Severe Acute Influenza Consortium (MOSAIC)**led by Peter Openshaw. The consortium was a wide-ranging multi-centre study of influenza pathogenesis in patients hospitalised with severe H1N1 disease during the pandemic, funded by the MRC and the Wellcome Trust (£2.7m). This study built on the existing strengths in the Centre for Respiratory Infection at Imperial College London to study the pathogenesis of respiratory viral diseases and to enhance pandemic preparedness and response.

MOSIAC was anticipated to provide invaluable data regarding the viral and host factors associated with progression to severe influenza and eventually lead to studies of new interventions that might reduce the risks of complications and fatal outcomes. Researchers at Imperial worked with co-investigators in London, Liverpool, the HPA, NIMR, Edinburgh, Glasgow, Nottingham and Oxford. The work built on the UK's Clinical Research Networks and was linked to the Department of Health's clinical information network (FluCIN). Such a large-scale cooperative project had never before been attempted for pandemic influenza (45 co-investigators across eight cities).

MOSIAC has already delivered scientific advances. Patient samples from MOSIAC recently enabled identification of a gene (IFITM3), variants of which could help explain why influenza becomes a life-threating disease to some people while it

[31] Collaborations lead UK research community response to H1N1 pandemic (MRC Website November 2009) http://www.mrc.ac.uk/Newspublications/News/MRC006480

has only mild effects in others. **The work was published in *Nature* in March 2012**[32].

This finding has now been corroborated by an unpublished study on Han Chinese (25 per cent of normal cases and 70 per cent of severe flu cases have the defective gene). This might explain why so many pandemics begin in this part of the world.

MOSAIC has been used as a template for a new international network of consortia (ISARIC) funded by the MRC, the Wellcome Trust, the Bill & Melinda Gates Foundation, INSERM, Li KaShing Oxford Global Health Programme and the Singapore Ministry of Health. ISARIC[33]**was formally launched in July 2012** and is run from Oxford. ISARIC currently draws together the work of 70 networks across six continents researching bird flu, swine flu and SARS, with the aim of improving global preparedness for outbreaks, and thereby saving lives.

Working towards better diagnosis and treatment of idiopathic pulmonary fibrosis

Dr Andy Blanchard, Director of External Discovery at GlaxoSmithKline, is working with scientists at the University of Nottingham and Queen Mary, University of London to evaluate a potential biomarker of idiopathic pulmonary fibrosis that could lead to better diagnosis and treatment of the disease. The MRC is funding the research through an MRC Industry Collaboration Award (MICA).

Idiopathic pulmonary fibrosis is diagnosed in around 4,500 people in the UK every year. About half of those people die within three years as a result. Currently there is no treatment for the disease and no way of predicting how quickly it will progress in individual patients.

The collaboration between academic and industry scientists is focusing on a molecule called αvβ6 integrin, which might produce a sea change in the hunt for new treatments for pulmonary fibrosis. Integrins are involved in signalling between cells and their environment: such interactions between surface integrins and the extracellular matrix provide key signals determining cell fate. αvβ6 integrin is implicated in the pathology of various conditions such as cancer, chronic wounds and fibrosis, and as such is a potential target for treating these diseases.

Researchers at the University of Nottingham, GlaxoSmithKline (GSK) and Queen Mary, University of London (QMUL) have come together to assess whether expression of αvβ6 integrin in the lungs can be used to measure the extent of pulmonary fibrosis and as a measure of disease progression in an animal model of lung fibrosis. Ultimately this could lead to new and improved ways of assessing the effectiveness of potential new drugs in treating patients.

Dr Andy Blanchard, Director of External Discovery at GSK, says:

[32] IFITM3 restricts the morbidity and mortality associated with influenza Nature 484, 519–523 (2012) doi:10.1038/nature10921 http://www.nature.com/nature/journal/v484/n7395/full/nature10921.html

[33] http://isaric.tghn.org/about/

"Biomarkers that predict efficacy mean we can get better information from shorter clinical trials. Because they are shorter and less expensive, we are able to run more trials, which means we can test more candidate drugs at different doses and be sure we will find the best option for patients as quickly as possible."

Dr Blanchard is working with Dr Gisli Jenkins at Nottingham and Dr John Marshall at QMUL, funded by GSK and an MRC Industry Collaboration Award (MICA). "We all believe in this integrin as a target but each of us has only one piece of the jigsaw," he says. "Nottingham has strong clinical links – they have the patients who need treating – but also an academic interest in integrins and their role in pulmonary fibrosis. They have animal models and imaging capacity but no drug discovery capability. At GSK, we have a wealth of experience in preclinical and clinical development of new drugs.

"At QMUL, Dr Marshall has the missing link: a labelled peptide that targets αvβ6. Putting all our expertise together, we can use the peptide to label αvβ6, visualise it using imaging technology and measure how it relates to progression of fibrosis in our model, as well as monitoring in vivo the effect of novel inhibitors of fibrosis on disease progression."

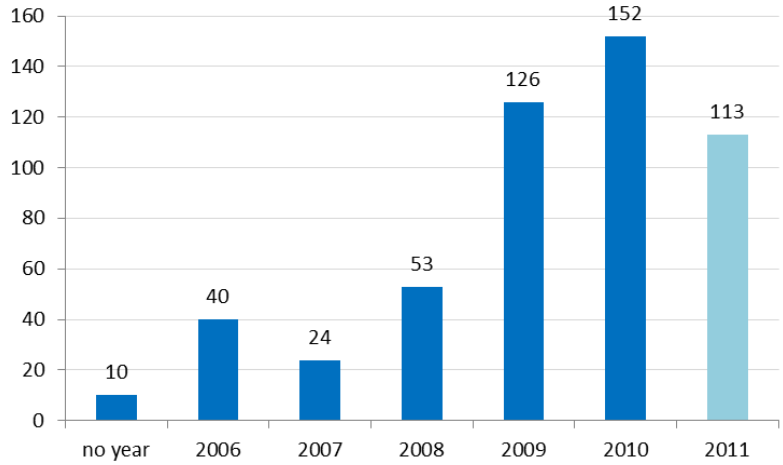
Dr Blanchard says collaboration between private and academic sectors is the future of the pharmaceutical industry as companies acknowledge how important it is to augment existing expertise in-house with scientific excellence externally. "MICA is a tremendous initiative," he says. "It will accelerate the development of new drugs to meet clinical needs – and it's helping do that without lots of bureaucracy. The form was just three or four pages, relatively straightforward, clearly defining the roles and the IP situation for the academics and the company. It's been a very positive experience."

4.1.3 Products or interventions

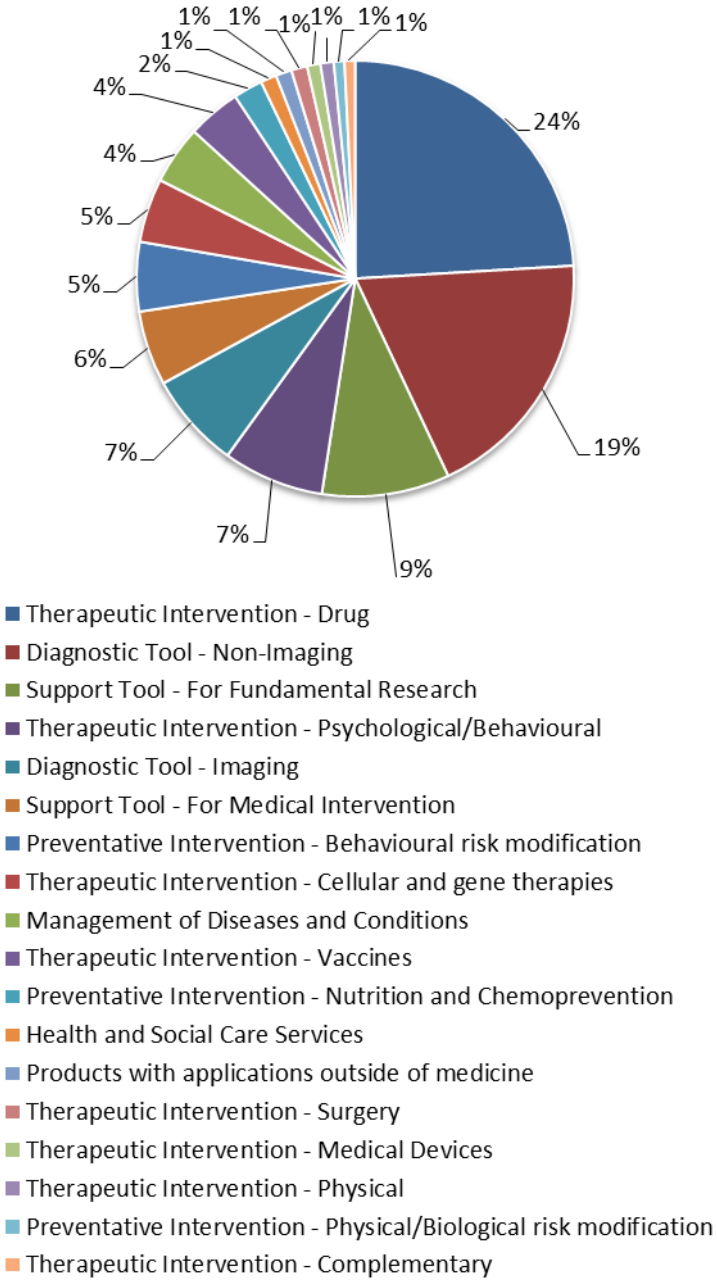
Products or interventions includes the development of diagnostic tools such as screening; therapeutic interventions such as drugs, vaccines, medical devices or surgery; preventive interventions; health/social care services; and several others. MRC e-Val also records the current stage of development that the product/intervention has reached.

Reports detailing 518 products and interventions were entered into MRC e-Val in 2011, from 366 awards.

Note that data from 2011 is partial. The chart below shows the products and interventions based on the year in which they were first produced.



The chart below shows the percentage of each type of product or intervention reported between 2006 and 2011.



See Annex 2 Section 4.1 Knowledge generation, for actual numbers.

Specific examples of products in development:

Hashim Ahmed (University College London Hospital)
MRC co-funded trial[34] of high-intensity focused ultrasound (HIFU) treatment for prostate cancer, which showed that 9 out of 10 patients were free of cancer 12 months after treatment with no major side effects (incontinence or impotence). HIFU shows promise as an alternative to current treatments.

[34] Focal therapy for localised unifocal and multifocal prostate cancer: a prospective development study Lancet Oncology (2012) doi:10.1016/S1470-2045(12)70121-3

Francesco Muntoni (University College London)
An MRC co-funded clinical trial[35] demonstrated that a gene-based drug, initiating "exon skipping" is effective in raising the levels of a shortened, semi-functioning dystrophin protein in sufferers of Duchenne Muscular Dystrophy, a fatal muscle wasting disease in boys caused by a faulty dystrophin gene.

Steve Brown (MRC Mammalian Genetics Unit)
Following research to define potential molecular pathways involved in the pathogenesis of otitis media[36], work is underway to test *in vivo* whether compounds inhibiting these pathways would be useful in treating the disease. Promising results led to MRC Technology filing a patent to protect this novel finding, and the work has been extended to verify the *in vivo* results by collecting clinical effusion samples from children with chronic glue ear. Current development work has supplementary support from the Translational Research Initiative for Hearing scheme run by Action on Hearing Loss (formerly RNID).

Carole Ward (Nottingham University)
Developed and patented a heart rate sensor specifically for new-born infants[37]. Preliminary work has demonstrated its utility on babies in intensive care. Further development is underway to assess accuracy, reliability and acquisition time. The aim is to improve resuscitation in those infants at greatest risk of short and long term sequelae. Most recent work supported by DPFS Portfolio Award.

The Loughborough Occupational Impact of Sleep Scale (LOISS)[38]
LOISS is a questionnaire used to assess sleep related occupational impairment in both clinical and non-clinical populations. The scale has been adopted by the RCUK-funded New Dynamics of Ageing "working late" project.

Adrian Hill and Simon Draper (University of Oxford)
Researchers have developed adenovirus-based vaccine vectors, produced these to GMP grade suitable for immunisation against malaria, and carried out Phase I safety and immunogenicity studies. The results show improvements over previous approaches[39], and may provide a route to an effective malaria vaccine.

[35] Exon skipping and dystrophin restoration in patients with Duchenne muscular dystrophy after systemic phosphorodiamidatemorpholino oligomer treatment: an open-label, phase 2, dose-escalation study *Lancet*, Volume 378, Issue 9791, Pages 595 – 605doi:10.1016/S0140-6736(11)60756-3 http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2811%2960756-3/abstract

[36]HIF-VEGFpathways are critical for chronicotitismedia in Junbo and Jeffmousemutants*PLoS Genet.* (2011);7(10):e1002336

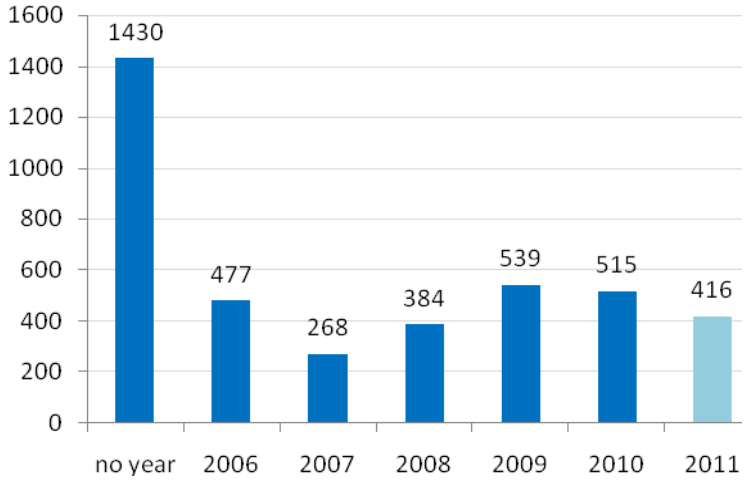
[37] Heartlight - Acquisition Times for a Novel Forehead Heart Rate Sensor in Delivery Room Resuscitation of Preterm Infants *Pediatric Research*70, 674 (2011) doi:10.1038/pr.2011.899

[38] The Loughborough Occupational Impact of Sleep Scale (LOISS): a new instrument for research and clinical practice. *Behav Sleep Med*.(2011);9(4):243-56. doi: 10.1080/15402002.2011.606775.

[39] Clinical Assessment of a Recombinant Simian Adenovirus ChAd63: A Potent New Vaccine Vector *J Infect Dis.* (2012); 205(5): 772–781. doi: 10.1093/infdis/jir850

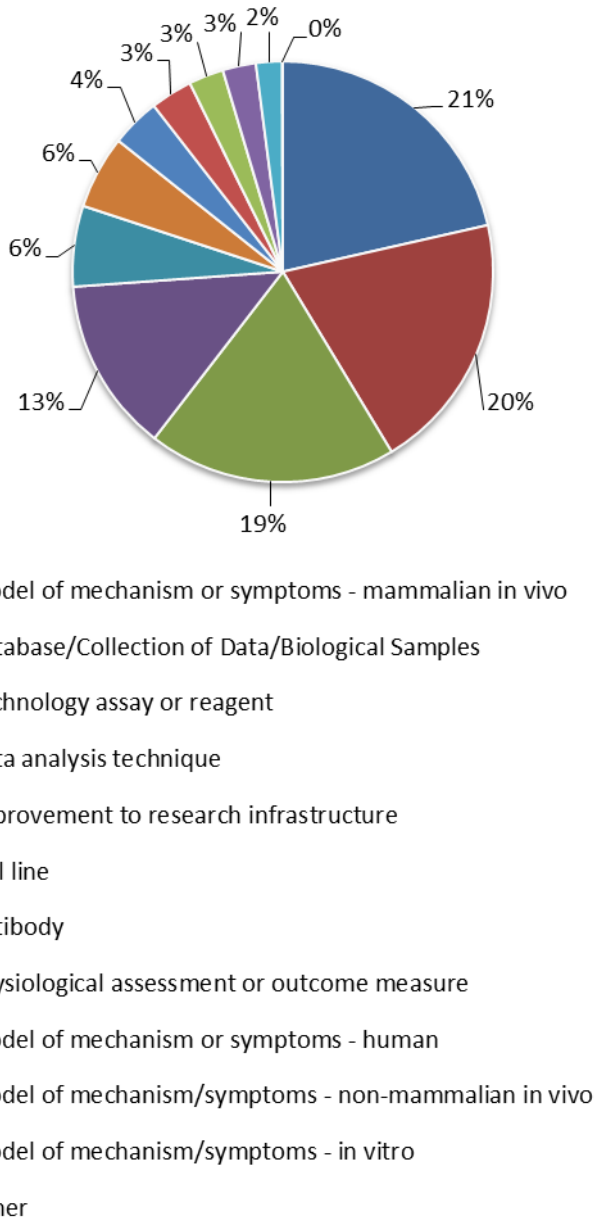
4.1.4 Research materials

4,029 reports detailing research materials were entered into MRC e-Val in 2011, from 1,968 awards.



Research materials covers reports of databases, data analysis techniques, cell lines, models of mechanisms or symptoms, new equipment, and so on.

The chart below shows the percentage of each type of research material reported.



See Annex 2 Section 4.1 Knowledge generation, for actual numbers.

Synthetic biology – research at MRC LMB re-writes biology rule book

Philipp Holliger, Jason Chin and others at LMB have been re-writing the fundamental chemical rules of biology, shedding light on its origin, and opening up new ways of exploiting cells as factories for complex polymers that may transform chemical engineering/medicinal chemistry.

Jason Chin has systematically amended the central rules by which RNA is transcribed into proteins. He established an elegant way of incorporating amino acids not found in nature into proteins (suppression of the amber stop codon in

concert with a mutated ribosome[40]), and even engineered new ribosomes that could translate a *quadruplet* rather than triplet genetic code[41]. Changing this central dogma expanded the genetic code from 64 codons to 256; an advance that was hailed by New Scientist as "Genetic code 2.0: Life gets a new operating system"[42]. This work was recognised by the Royal Society in 2009, and brought Jason an EMBO Gold medal in 2010. His group has attracted prestigious European Research Council and HFSP grants.

Jason extended this approach from bacteria, to engineer the ability for the nematode worm to utilise a new amino acid in 2011[43], the first time that this had been achieved in a multicellular animal. This was extended further to the fruit fly (published August 2012)[44] a far more complex organism, opening up the possibility of utilising the new approach to study processes important to behaviour, learning and neuro degeneration.

The group at LMB has provided an entirely new toolkit for science, allowing the engineering of proteins with unprecedented precision. This not only provides a new way of investigating disease processes at the molecular level, but also provides the ability to produce therapeutics with properties not currently possible in nature. These synthetic proteins could be designed with altered stability, affinity or other properties, for example gaining a step change advantage over bacterial or viral pathogens that have to abide by current biological constraints.

Similarly exceptional progress has been seen in the groups of Philipp Holliger and Vitor Pinheiro. Philipp pioneered an approach to select DNA polymerases (the enzymes that synthesise new DNA strands) with new functionality. New DNA polymerases were engineered that can copy a DNA template into an "XNA" polymer and the XNA polymer back into DNA (published April 2012)[45].XNAs ("xeno" nucleic acid) have entirely different molecules in place of the sugar phosphate backbone in DNA. Six different XNAs have been tested and all found to be more stable than DNA, capable of being copied accurately and of evolution. This may solve the limitation that nucleic acids are difficult to utilise therapeutically, as they are quickly degraded in the body (and trigger an immune response)[46]. The production of functioning XNAs has also stimulated discussion about whether they could have existed in a "pre-DNA" world. It has even been suggested that XNA may be used as a biological information store, with computer "bits" encoded as bases.

[40]Evolved orthogonal ribosomes enhance the efficiency of synthetic genetic code expansionhttp://www.fli-leibniz.de/www_bioc/journal_club/wang.pdf

[41] Encoding multiple unnatural amino acids via evolution of a quadruplet-decoding ribosome http://www.nature.com/nature/journal/v464/n7287/full/nature08817.html

[42]http://www.newscientist.com/article/dn18523-genetic-code-20-life-gets-a-new-operating-system.html

[43] Expanding the Genetic Code of an Animal http://pubs.acs.org/doi/abs/10.1021/ja2054034

[44] Expanding the genetic code of *Drosophila melanogaster* http://www.nature.com/nchembio/journal/v8/n9/full/nchembio.1043.html

[45] Synthetic Genetic Polymers Capable of Heredity and Evolution http://www.sciencemag.org/content/336/6079/341.abstract

[46] The only therapeutic nucleic acid on the market is the anti-angiogenicPegaptanib (Macugen™) for wet age-related macular degeneration.

Specific examples of research materials:

Fibromed Ltd. (University of Edinburgh spin out)
Researchers at the MRC/University of Edinburgh Centre for Regenerative Medicine have discovered ways to increase the production of hepatocytes, key cells needed to repair liver function, in regenerating liver tissue[47]. In part it is this expertise which led to setting up the spin out company Fibromed[48] in 2011.Fibromed will provide tools and technologies to customers interested in predictive liver models.

International Stem Cell Initiative[49] (ISCI, Peter Andrews, Sheffield University)
ISCI is a worldwide collaborative effort to establish basic criteria and techniques that will underpin the eventual development of applications for human embryonic stem (hES) cells in human medicine. The ISCI database gathers together information on bone fide human embryonic stem cell lines from around the world. The data for the stem cell registry is available for researchers to download and analyse for themselves and has led to several important publications[50].

Professor Irene Higginson (King's College London)
The Palliative care Outcome Scale (POS) was initially developed in 1999 for use with patients with advanced disease, and to improve outcome measurement by evaluating many essential and important outcomes in palliative care. POS has been continually tested and improved by researchers around the world. In 2011 an online version of POS was launched[51]. The work was linked to an EU funded project on outcome measures and collaboration with this group

Dr Wing Tong (Newcastle University)
Researchers at Newcastle University have undertaken a novel biophysical and computational approach towards understanding term and preterm labour by developing a mathematical model of uterine smooth muscle[52]. This research tool is the first open source mathematical model with detailed descriptions of membrane excitability and calcium-dependent contraction in uterine smooth muscle cells. The source code of the model is freely available to the public and the international research community.

Professor Alasdair MacLullich (University of Edinburgh)
Researchers at the University of Edinburgh and NHS Lothian have developed a new screening tool for delirium and cognitive impairment called the 4 A's Test or 4AT[53]. The tool is freely available and is being used in research projects as well as in routine clinical practice. The 4AT was initially produced to help increase the local rates of detection of delirium in acute general hospital settings.

Dr Arno Muller (University of Dundee)
Several transgenic Drosophila fly stocks have been established in which the enzymes that control O-GlcNAcylation can be manipulated in vivo, creating

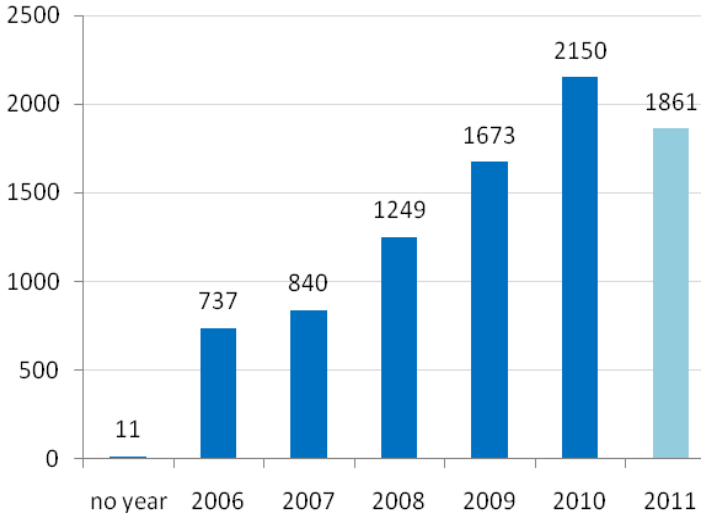
[47] Macrophage-derived Wnt opposes Notch signaling to specify hepatic progenitor cell fate in chronic liver disease; Boulter, LM et al *Nature Medicine* 18,572–579(2012)doi:10.1038/nm.2667
[48] Fibromed website http://www.fibromed.co.uk/
[49] http://www.stem-cell-forum.net/ISCF/initiatives/isci/
[50] Screening ethnically diverse human embryonic stem cells identifies a chromosome 20 minimal amplicon conferring growth advantage Nature Biotechnology 29, 1132–1144 (2011) doi:10.1038/nbt.2051
[51] www.pos-pal.org
[52] http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0018685
[53] http://www.the4at.com/

mutant animals and tissues with either gain of function or loss of function. These tools provide invertebrate animal models to study the nutrient and metabolism dependent connection to cell signalling pathways that are relevant for human disease[54].

4.1.5 Awards and recognition

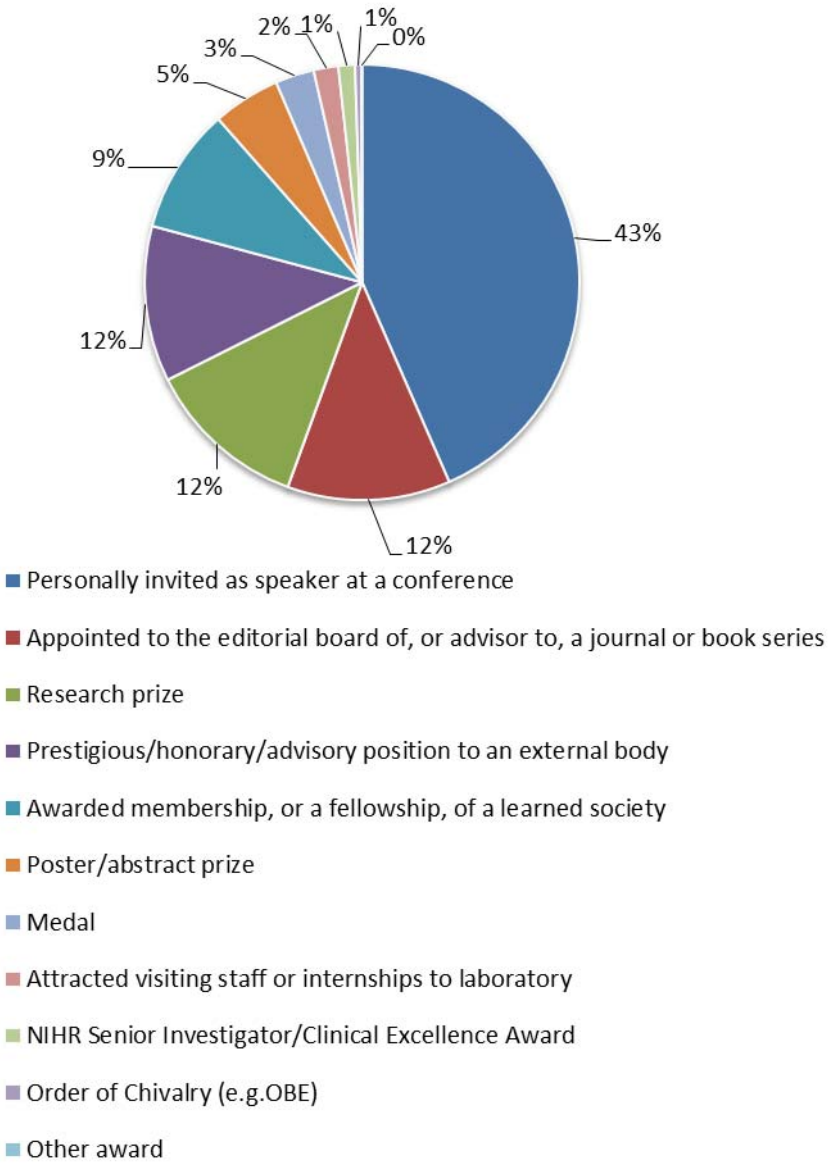
The MRC captures, via MRC e-Val, details about awards and other types of recognition that MRC funded research groups receive. These are often an indication of the long-term impact delivered by researchers and the demand for their expertise and advice.

8,521 reports made in this section, from 1,901 awards.



Awards and recognition are categorised into types which are shown in the chart below, but these types fit broadly into five areas— involvement in the publication of research (such as the editor of a journal), membership of learned societies (for example the Royal Society), prize lectures, poster prizes, and other honours (eg Order of the British Empire).

[54] http://www.lifesci.dundee.ac.uk/groups/arno_muller/



See Annex 2 Section 4.1 Knowledge generation, for actual numbers.

Specific examples of awards and recognition:

Professor Usha Goswami (Director of the Centre for Neuroscience in Education, University of Cambridge)
The Aspen Brain Forum awarded Professor Goswami the Senior Investigator Prize in Neuroeducation[55], 2011, New York Academy of Sciences, for "innovation and excellence in translating discoveries from cognitive neuroscience into innovative curricula or new tools that enhance learning inside or outside of the classroom".

[55] http://www.cne.psychol.cam.ac.uk/news/aspen-brain-forum-senior-investigator-prize

Professor Peter Coffey (Professor of Cellular Therapy and Visual Sciences, Institute of Ophthalmology)
Professor Coffey was awarded the 2011 Inaugural New York Stem Cell Foundation – Robertson Stem Cell Prize[56]for his pioneering work focusing on the use of human embryonic stem cells to cure Age-Related Macular Degeneration (AMD), a common and currently untreatable form of blindness.

Professor Nick Tyler (Director of the UCL CRUCIBLE Centre, University College London)
Professor Tyler is Chadwick Professor of Civil Engineering, and investigates the ways in which people interact with their immediate environments. He was appointed a CBE in the New Year's Honours 2011 for services to technology[57].

Professor Brian Greenwood (Former Director of the MRC Laboratories, Gambia)
In 2012 Professor Greenwood was knighted for services to malaria research in Africa[58].

Professor Stuart Allan (Faculty of Life Sciences, University of Manchester)
In 2011 Professor Allan was invited to serve as Senior Editor on the journal *Neuropharmacology* which is a well-established journal in the neuroscience field.

4.2 Human capital (stock)

The MRC funds postgraduate research training in several ways. A breakdown of the MRC studentship population as at July 2011 is shown in the table below:

MRC studentship funding route	Number of students	% of total
Doctoral Training Grant	859	48%
MRC intramural students	454	26%
Studentships in capacity development areas	231	13%
MRC centre studentships	120	7%
Industrial CASE studentships	109	6%
Total	1,773	

Sixteen universities in the UK receive a Doctoral Training Grant for PhD studentships based on their success at gaining grant income from the MRC; the more grant income, the more PhD students the university receives funding for.

After a pilot in 2010, 2011 saw the roll out of a new way of working with these universities: the MRC-Research Organisation Studentship Portfolio Agreements. These agreements provide a better foundation on which the MRC can work with universities to ensure that PhD students receive the highest quality provision, that studentships fulfil both the university's and the MRC's priorities, and that we can monitor the outcomes of MRC investment, all the while maintaining flexibility for the universities in how they deploy the PhD students.

[56] http://www.nyscf.org/grants/nyscf-robertson-prize
[57] http://www.ucl.ac.uk/ucl-iris-project/iris/staffprofile.php?ref=NATYL84
[58] Knighthood for Brian Greenwood
http://www.lshtm.ac.uk/newsevents/news/2012/item19326.html

Number of PhD students supported	Number of MRC-funded students registered on the Je-S system by academic year. From a snapshot of Je-S data taken on 21/07/2011 Total by academic year 2011/12 data not yet available 2010/11 410 2009/10 460 2008/09 488 2007/08 452
Number of Master's students supported	The MRC Advanced Course Master's in 2011/12 received 35 applications and awarded 20 block awards to HEI's, which each consisted of between 2–4 one-year Master's for three intake years (2012, 2013 and 2014). The number of studentships per intake year was between 66 and 70 (one RO had no intake in Year 1 and four students in year 2 and 3) at a cost of £1.35m per annum, with a total of 206 one-year Master's places awarded (£4.05m). The number of studentships are notional and do not take into account any possible leveraging of funds by the HEI (up to 50 per cent) The panel funded an even spread of applications across the three skills priority areas of advance in vivo sciences; biomedical imaging; and mathematics, statistics and computation.
Finishing rates	Approximately 90 per cent of MRC-funded students submit their thesis within five years of commencing their studies. Further details of this can be seen in Annex B Section 4.2 Human capital (stock).
Student funding/training schemes	<u>Industry CASE studentships</u> CASE awards provide PhD students with a first-rate, challenging research training experience, within the context of a mutually beneficial research collaboration between academic and partner organisations, eg industry and policy-making bodies. A yearly breakdown of the numbers of students under this scheme and the partnership organisations is shown in section 5.1.

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 speed up the progress of discoveries in the laboratory and turn them into products and interventions that

benefit the public and patients, and improve the economic productivity of the UK. The MRC works with the NIHR 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.

In 2011/12, 42 translational research awards totalling £34.1m were funded through the boards, the Developmental Pathway Funding Scheme (DPFS), Developmental Clinical Studies (DCS), Translational Stem Cell Research Schemes (TSCRS) and panels. Further details of some of these schemes can be found in Annex 2 Section 4.3.

In March 2012 the DPFS, which supported preclinical development, and the DCS scheme, which supported early phase clinical trials, were merged. The aim of this was to create a single funding scheme which can take a discovery through preclinical studies and into patients. The merged DPFS/DCS scheme will have a commitment budget of approximately £35m a year and by the end of March 2012 had received 75 outline applications.

Under the auspices of the OSCHR, we lead on the themes of experimental medicine, methodology and regenerative medicine, with NIHR leading on clinical evaluation and trials. We work together on developing the human capital needed to deliver the translational research agenda.

Experimental Medicine Challenge Grants is a new funding scheme that will support ambitious and innovative research tackling particular gaps in knowledge about human disease mechanisms, with the potential for new therapies to be produced. The MRC will make £20m a year available for the scheme, which was launched in February 2012.

Methodology research is the study of how to best design, analyse and evaluate medical and health research, and helps to ensure that discoveries are more quickly turned into benefits for patients and the general population. Currently the MRC and the NIHR put £5.5m into the MRC-NIHR Methodology Research Programme (£4.5m from the MRC and £1m from the NIHR). The programme has been successful in funding high-quality investigator-led proposals and is continuing with its aim to improve commissioned research, guided by a new advisory committee.

Regenerative medicine, encompassing stem cell therapies, tissue engineering and gene therapy, has the potential to deliver new treatments for a range of diseases.

In 2011 the MRC led, on behalf of the research councils and the Technology Strategy Board (TSB), the creation of a UK strategic plan for regenerative medicine, which will ensure that public sector research in the UK has a plan for future investment in regenerative medicine. The strategy was published in March 2012 and a key part of its implementation will be establishing a national programme in regenerative medicine to ensure that research council-funded science is seamlessly connected to commercial development.

Also launched in March 2012, the £25m MRC/EPSRC/BBSRC UK Regenerative Medicine Platform will address knowledge gaps and obstacles where more development is needed to underpin the delivery of new therapeutic approaches. The MRC had already contributed £1.6m to five industry-led studies developing new tools and technologies in regenerative medicine in December 2011, as part of a TSB-led programme seeking to develop industry-academia partnerships. The Biotechnology and Biological Sciences Research Council (BBSRC) and the

Engineering and Physical Sciences Research Council (EPSRC) were partners in the programme.

An example of translation using the story of the cancer drug Campath, which the MRC has been part of supporting from the 1970's through to the present time:

Campath – from bench to bedside

The MRC funds researchers to investigate important questions about human health and disease which ultimately provide health benefits for millions of people worldwide. But it often takes many years for our scientists' discoveries to be turned into a new drug or treatment. Here we tell the story of the cancer drug Campath, which originated from MRC research carried out in the 1970s.

1978
The MRC awards a grant to Professor Herman Waldmann, then a lecturer in the department of Pathology at Cambridge University, to investigate why people's immune systems ignore molecules present in their own bodies (immune tolerance).

Three years earlier, Dr Cesar Milstein at the MRC Laboratory of Molecular Biology (LMB) had discovered how to make cells that infinitely produce antibodies by fusing rat cancer cells and immune system cells together. Using this technology, Professor Waldmann makes an antibody which attacks immune system cells called lymphocytes. He calls it Campath, named after Cambridge Pathology.

1980s
LMB scientist Professor Greg Winter 'humanises' the first mouse antibodies by replacing the some parts of the mouse antibody with the equivalent human parts, making them better suited to medical use. Professor Waldmann's team use this technique to make a set of humanised antibodies from Campath, named Campath-1H.

Late 1980s
Campath-1H is safely and successfully used to treat patients with two types of blood cancer, lymphocytic leukaemia and non-Hodgkin lymphoma, in the first clinical trials of the drug. In these blood cancers, lymphocytes multiply out of control and live longer than they normally would. Campath-1H works by targeting lymphocytes for destruction, stopping them from crowding out healthy cells.

1997
Campath-1H is licensed to biotechnology company LeukositeInc, which collaborates with another company, ILEX Oncology, to carry out large-scale trials in many people to ensure that the drug is effective and has no dangerous side-effects.

2001
The US government's Food and Drugs Administration approves the use of Campath-1H for treating patients with the blood cancer B-cell chronic lymphocytic leukaemia whose disease does not respond to chemotherapy.

2012
Campath-1H, since acquired by Genzyme Corporation, is being used to treat thousands of cancer patients around the world, bringing in revenue of around $100 million per year. It is currently in late development for treating a second

disease: multiple sclerosis, in which lymphocytes play a part in destroying the insulating sheath around nerves. If it is deemed to be safe and effective for this purpose by regulatory agencies, the benefits of Campath could be extended to many millions more patients.

Examples of outputs/impacts in this area:

Phagenesis Ltd. (University of Manchester spin out)
Phagenesis[59] is based on the MRC-funded work of Dr Shaheen Hamdy, and is a medical device company focusing on the development of technology for the assessment, treatment and management of dysphagia (problems with swallowing) after a stroke. In 2011 the company announced having closed a €7m series B funding round designed to accelerate the company's development plans.

Summit Plc. (Oxford University spin out)
Summit's programme in Duchenne Muscular Dystrophy (DMD)[60] therapy is based on the work of Professor Kay Davies (Honorary Director of the MRC Functional Genomics Unit) who has been funded by MRC for more than 20 years. In December 2011 Summit announced that it had obtained funding for a phase I study in DMD patients from a consortium of DMD charities.

Graham Jackson (MRC Prion Unit)
MRC researchers have completed initial development for the world's first blood test for variant Creutzfeldt-Jakob disease (vCJD)[61]. Being able to detect the infectious agent via such a test is both vital to the epidemiological study of this disease, and to develop therapies. The test is currently in the early stages of clinical evaluation and has so far been used in the clinical care of around 30 patients.

MRC Human Nutrition Research Unit (MRC Human Nutrition Unit, Cambridge)
In 2012 AquaPharm, the Scottish biotechnology firm, announced a collaboration with the MRC HNU[62] to evaluate the potential of a new approach to digestive health. Called EndoSeaRch, the collaboration represents the first in-vivo application for a patented Aquapharm technology. Aquapharm is already developing a number of marine extracts as novel ingredients for food and skin-care products, and evaluating compounds derived from them as new drugs. It is now applying its expertise to intestinal bacteria.

4.4 Intellectual property activity

MRC Technology (MRCT) is a key partner in our translational strategy, working to translate cutting-edge scientific discoveries from MRC units and institutes into products, and managing our intellectual property.

[59] Phagenesis Ltd. http://www.phagenesis.com
[60] Summit Plc. DMD research programme http://www.summitplc.com/DMD-utrophin-upregulation.aspx
[61] Detection of prion infection in variant Creutzfeldt-Jakob disease: a blood-based assay The Lancet, (2011) Volume 377, Issue 9764, Pages 487 - 493, doi:10.1016/S0140-6736(10)62308-2
[62] Aquapharm& Medical Research Council evaluate EndoSeaRch™- a new approach to digestive health (May 2012) http://www.aquapharm.co.uk/biotechnology-news/aquapharm-medical-research-council-evaluate-endosearch%E2%84%A2-a-new-approach-to-digestive-health.aspx

During 2011/12 changes have been made to MRCT governance to strengthen its independence from MRC following the adoption of new articles of association effective from 31 January 2012. The organisation will now work with the MRC under contract. In 2011/12 licensing income to the MRC from all sources was £78.9m during the year (2010/11 £65.8m).

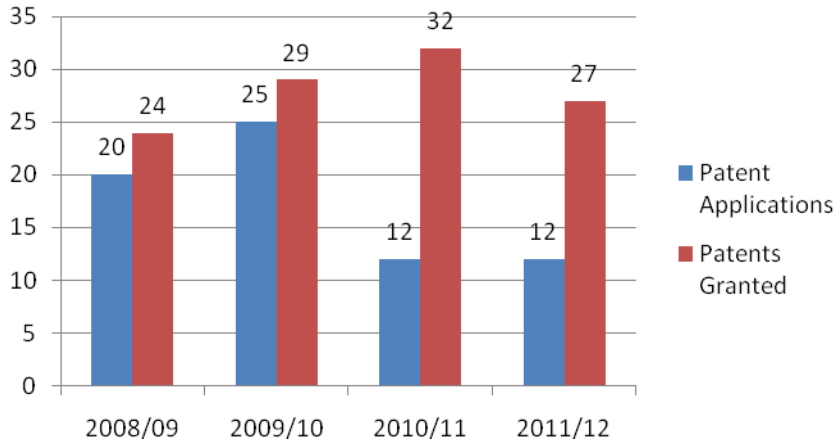
MRCT provides management of both new intellectual property and commercial opportunities arising from research by MRC staff, and the management of existing MRC intellectual property and on going licensing arrangements. In 2011/12, 27 patents were granted and 169 agreements were signed.

MRCT has also managed the intellectual property issues involved in the transfer of the MRC Human Genetics Unit to the University of Edinburgh, and the closure of the MRC Human Reproductive Sciences Unit and opening of the MRC Centre for Reproductive Health in its place.

Patent applications and patents granted

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

The data presented here and below are MRCT data and therefore represent the intramural part of the MRC portfolio only.



The decision whether to file a patent or not is based on a range of technical, legal and commercial factors. As research is a highly competitive activity, there can be conflict between the rapid dissemination of information and the requirement to protect an invention with a patent. As such, this does not fully reflect the number of patentable inventions from MRC unit funding.

Patent information is also collected through MRC e-Val: there were 427 unique reports of patents granted/published and 145 reports of intellectual property being licensed by 2011 (34 per cent). This is a similar proportion to that found in the analysis of the data collected in MRC e-Val at the end of 2009 and 2010.

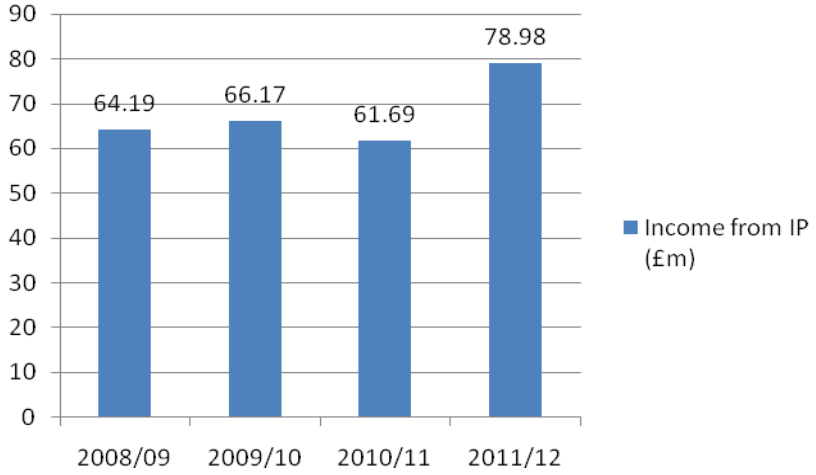
Spin outs / new businesses created

MRCT has managed the creation of two new businesses in the last four years, so this represents only the MRC's intramural programme.

The MRC also collects data on spin out companies through MRC e-Val. MRC funding has contributed to the set up or growth of 86 companies, 49 of which have been formed since 2006. It is estimated that these companies represent more than 450 new highly skilled jobs.

Income from intellectual property

Income from intellectual property (IP) includes licence income and receipts from sales of shares in MRC companies.



Specific examples of commercialisation:

Pro-Cure Therapeutics (York)
Pro-Cure[63] is a spin out company from the Yorkshire Cancer Research Unit at the University of York, in part based on research from the MRC-funded prostate cancer collaboratives (led by David Neal and Norman Maitland). Recently the company has been developing siRNA inhibition of cancer stem cells, and was granted a fundamental patent on prostate cancer stem cells.

James Sharpe (formerly of the MRC Human Genetics Unit)
Optical projection tomography (OPT) is a relatively new imaging technique, developed by the MRC, in 2002[64]. The aim of OPT is to accurately image the development of 3D structures. It works by projecting light through a whole specimen. Since 2005 MRCT has provided 39 OPT microscope systems and training courses to laboratories around the world, generating income of £2.6million[65]. The system has also been a feature at the EMBO Practical Course on 3D Developmental Imaging in 2009 and 2010, and in 2011 two out of 21 winners in the Wellcome Trust image awards[66] were taken using OPT. In 2012 the technique was applied to studying the growth of breast cancer cell cultures[67].

The UK Collaborative Trial of Ovarian Cancer Screening (UKCTOCS)

[63] http://www.pro-cure.uk.com/
[64] Optical Projection Tomography - a better way to view tissues and genes http://www.mrc.ac.uk/Achievementsimpact/Storiesofimpact/OpticalProjectionTomography/index.htm
[65] http://www.bioptonics.com/Home.htm
[66] http://www.wellcomeimageawards.org
[67] Determining tamoxifen sensitivity using primary breast cancer tissue in collagen-based three-dimensional culture Biomaterials Volume 33, Issue 3, January 2012, Pages 907–915

Abcodia Ltd.[68] was established as the means by which diagnostic, pharmaceutical and technology companies, as well as academic groups, can access serum samples collected in UKCTOCS (funded by the MRC) for the purpose of ethical biomarker validation and discovery. In 2011 Abcodia and Oxford Gene Technology (OGT) begin collaborative work to improve the early detection of pancreatic cancer. In 2012 Abcodia announced a second collaboration with VolitionRX to discover blood-based biomarkers for cancer.

Platelet Solutions Ltd. (University of Nottingham)
Platelet Solutions Ltd.[69] aims to use novel technology to measure platelet function simply and accurately in any clinical setting. In 2011 the company won the Start Up Award in Medilink East Midlands Business Competition, and the award of an MRC DPFS grant led to formal incorporation.

[68] http://www.abcodia.com/
[69] http://www.plateletsolutions.co.uk/

5.0 Outcomes

5.1 Human capital (flow)

Encouraging our students and fellows to establish mutually beneficial relationships with industry is key to ensuring that the UK has a skilled workforce that delivers for the UK in terms of both health benefits and economic returns.

In 2011/12, the MRC sustained a recent increase in support for our MRC Industry CASE Awards scheme: 35 awards were made in the year, with 50 per cent of students working with small- and medium-sized enterprises.

In January 2011 we launched a new way of working with our fellows to create industry-aware researchers with the skills and knowledge to drive forward translational medicine. We created an Industry Partnership Panel made up of MRC staff and experts from industry to advise fellows face-to-face on incorporating an industry component into either their existing fellowship (by 'topping up' with a new MRC Fellowship – Partnership Award) or a new fellowship proposal. All fellowship schemes are now open to industry collaboration, breaking down perceived barriers to industry collaboration among talented MRC trainees.

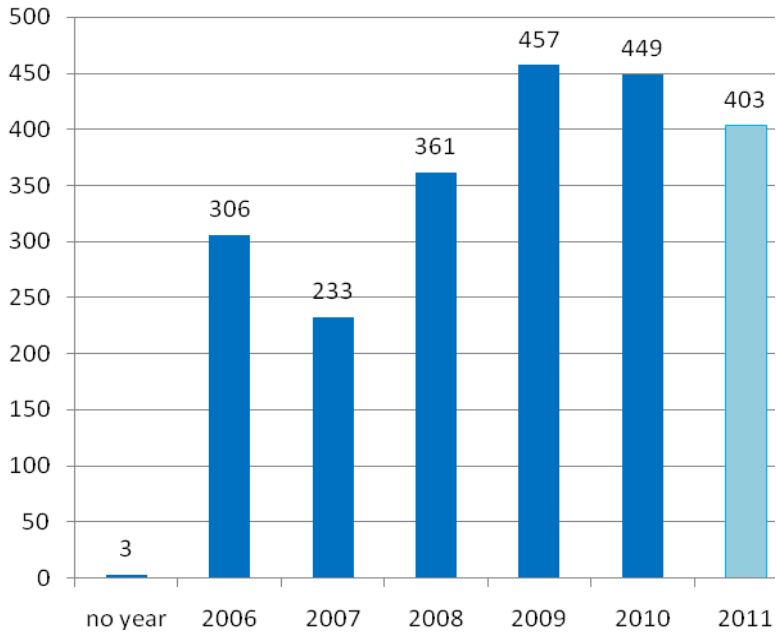
The MRC also agreed in May 2011 to sponsor the Technology Strategy Board-coordinated Knowledge Transfer Partnership scheme. The scheme offers the opportunity for postdoctoral researchers to carry out a placement in an academic-industry collaboration, building skills and sharing knowledge between the organisations.

Destinations of leavers	Data is collected on the first destination of PhD students qualifying or completing their courses through the Destination of Leavers from Higher Education. This data shows that approximately 51 per cent are in higher education, 11 per cent go into industry and 39 per cent go into an R&D (sector not known) role. Further data is available on this in Annex B section 5.1.
Numbers of student placements in user organisations	The MRC Industry CASE Award scheme is in partnership with industry or policy-making bodies. In 2011/12 the MRC awarded 33 CASE studentships. Numbers of CASE studentships awarded in previous years can be found in Annex B section 5.1.
Placements in partnerships organisations	In 2011/12 we awarded 15 (out of 33) Industrial CASE Awards to SMEs. The industrial partners for all 33 awards in 2011/12 are listed in Annex A section5.2.

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 has 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 direct impact on the public and result in significant impact. Information on influence on policy and practice is collected through MRC e-Val.

Influence on policy and practice	There were 2,212 reports of policy influences between 2006 and 2011, reported by 825 awards. The following chart shows the number of reports of influence on policy by the year that it was realised, note that 3 were reported without a 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 – 'instances of influence' and 'value/changes induced' and are shown in the metrics below.
Instances of influence	Influences on policy-setting processes: 1,735 reports between 2006 and 2011. This data includes reports of: • Membership of a guideline committee • Participation in a national consultation • Participation in an advisory committee • Gave evidence to a government review • Influenced training of practitioners or researchers
Value/changes induced	Citations in key policy documents: 475 reports between 2006 and 2011. This data includes reports of: • Citation in clinical guidelines • Citation in clinical reviews • Citation in other policy documents • Citation in systematic reviews

Specific examples of influences on policy:

Owain Hughes (MRC Clinical Training Fellow, University College London)
The Department of Health has made a decision to adopt the quadravalent vaccine Gardasil into the National Immunisation Programme, replacing the bivalent vaccine Cevarix[70]. Working with the Health Protection Agency, Dr Hughes was able to use data collected from across the UK on the prevalence and cost of treating recurrent respiratory papillomatosis to model potential cost savings emerging from adopting the quadravalent vaccine versus continuing with the bivalent vaccine. These data were presented to the Department of Health and published in the BMJ[71].

Avon Longitudinal Study of Parents and Children (ALSPAC) (University of Bristol)
ALSPAC has supported research resulting in a wide range of potential policy impacts. In 2012 results from the cohort, which celebrated its 21st birthday in 2012, provided evidence that low levels of vitamin D in childhood increases the risk of developing depression later in life[72]. In 2011 data from the cohort was used to reassure the public that swimming in chlorinated pools did not increase the risk of asthma or allergic symptoms[73]. ALSPAC data was also used in a 2011 Department of Education study[74] highlighting the importance of language in early educational outcomes, which influenced a new national communication scheme.

European Prospective Investigation on Cancer (EPIC) (MRC Epidemiology Unit)
EPIC is the largest study of diet and health ever undertaken, having recruited over half a million (520,000) people in 10 European countries. The study has enrolled 87,000 participants in the UK and this work is led by MRC-supported groups in Cambridge and Oxford, with funding also from CRUK, BHF, NIHR and the European Commission. The study has been key to confirming that a combination four dietary factors (fibre, fish, red and processed meats) plays a major role in colorectal cancer etiology, in addition to alcohol intake, obesity and low physical activity. In 2011 results from the study[75] showed that as many as one in 10 cases of cancer in men and one in 33 in women may be caused by past or current alcohol intake (in 2008, in the UK, this corresponds to 13,000 out of 304,000 cases). The results also highlighted that men that drank more than two standard drinks and women that drank more than 1 standard unit a day were particularly at risk, a threshold lower than the current NHS guidelines.

David Conway (MRC Unit, The Gambia)
Intermittent preventative treatment in infants (IPTi) is recommended by the WHO as part of the global strategy for malaria control. Research in The Gambia has shown that IPTi can be effectively delivered to children as part of the expanded

[70] HPV vaccine to change in September 2012 (Department of Health 2011) http://mediacentre.dh.gov.uk/2011/11/24/hpv-vaccine-to-change-in-september-2012/
[71] Comparing bivalent and quadrivalent human papillomavirus vaccines: economic evaluation based on transmission model BMJ 2011;343:d5775
[72] Children as young as nine at risk of depression due to vitamin D deficiency http://www.bristol.ac.uk/alspac/news/2012/42.html
[73] Swimming Pool Attendance, Asthma, Allergies, and Lung Function in the Avon Longitudinal Study of Parents and Children Cohort, Font-Ribera et al. *Am. J. Respir. Crit. Care Med*.(2011) vol. 183 no. 5 582-588
[74]Investigating the role of language in children's early educational outcomeshttps://www.education.gov.uk/publications/eOrderingDownload/DFE-RR134.pdf
[75] Alcohol attributable burden of incidence of cancer in eight European countries based on results from prospective cohort study *BMJ* 2011;342doi: 10.1136/bmj.d1584

programme on immunisation, and that the drugs used do not impair serological responses to vaccines[76].

Matthew Ridd (MRC Clinical Training Fellow, University of Bristol)
During his MRC-supported fellowship, Dr Ridd explored the influence of continuity on identification and care of patients with psychological problems in general practice[77]. He subsequently served on the development group for the new NICE guideline for common mental health disorders[78], which highlighted the importance of continuity of care.

Petra Meier (Sheffield Alcohol policy model, University of Sheffield)
Research in the MRC CAPER Cluster has provided evidence which has led to policy changes or promoted the re-evaluation of alcohol policy in Scotland and England. The research, which shows that increasing alcohol prices reduces crime, is cited in the new UK Government Alcohol Strategy[79], and has influenced the minimum price set in Scotland[80]

5.3 Public engagement

"The MRC is funded by the UK taxpayer. We recognise our responsibility to inform and involve the public, policy-makers and our partners about our work. Through our initiatives, many of which involve MRC-funded scientists, we develop effective relationships with a range of audiences. "MRC Strategic Plan 2009–2014, Research Changes Lives[81].

A major aim of the MRC is to increase public awareness of how research benefits individual lives and society as a whole. We also aim to build public confidence and trust in the MRC and its work. Our public engagement programme supports these aims.

Public engagement events by type
MRC e-Val collects information about dissemination activities between MRC funded researchers and non-academic audiences. Between 2006 and 2011 there were 11,719 reports of dissemination activities (plus one without a year) reported across 4,019 awards, giving an average of almost three dissemination activities reported for each award. See Annex B section 5.2 for further data on the types of dissemination activities reported by MRC researchers.

Funding for public engagement
All MRC-funded researchers are supported in their public engagement work by a network of MRC regional communication managers who identify opportunities,

[76] Two Strategies for the Delivery of IPTc in an Area of Seasonal Malaria Transmission in The Gambia: A Randomised Controlled Trial *PLoS Med*. 2011 February; 8(2): e1000409.
[77] Patient-Doctor Depth-of-Relationship Scale: Development and Validation *Ann Fam Med*. (2011); 9(6): 538–545. doi: 10.1370/afm.1322
[78]Common mental health disorders: Identification and pathways to care (The British Psychological Society and The Royal College of Psychiatrists, 2011) http://www.nice.org.uk/nicemedia/live/13476/54604/54604.pdf
[79]The Government's Alcohol Strategy (March 2012) http://www.homeoffice.gov.uk/publications/alcohol-drugs/alcohol/alcohol-strategy?view=Binary
[80]Sheffield University study adjusts booze price impact http://www.bbc.co.uk/news/uk-scotland-scotland-politics-16812662
[81] MRC Strategic Plan 2009 – 2014, Research changes lives. http://www.mrc.ac.uk/About/Strategy/StrategicPlan2009-2014/index.htm

offer help and advice, organise training and provide seed funding for projects. In 2011 they provided public engagement, writing and media training for 175 scientists. Training is delivered before an event or interview, to improve the quality of the engagement and to help ensure scientists have an opportunity to consolidate their skills. The corporate budget for public engagement in 2011/12 was £373,468.

Face-to-face engagement
In 2011 more than 200 MRC scientists at all levels took part in eight major UK science festivals, presenting activities that illustrated their research and described its impact on human health and the economy. An estimated 54,000 people, including school-age children, teachers and parents, and interested members of the public, met MRC scientists at these festivals and more than 7,000 visitors took home our public-facing booklet, *Changing Lives*, helping ensure a legacy from the events. Feedback was overwhelmingly positive, with ratings of 90 per cent being given by visitors and many saying that the MRC activities made them want to find out more about medical research.

Media and social media engagement
In order to reach broad public audiences, the MRC encourages scientists to use social and mass media to share research outcomes. In 2011 the MRC press office generated 2,496 articles featuring MRC research discoveries in the UK media, of which 1,019 articles featured in national media. These are estimated to have reached in excess of 20 million people. The MRC's digital, social and print media channels attracted around 700,000 visits from 390,000 unique visitors including 3,000 Twitter followers. The MRC magazine, *Network*, reached more than 6,500 readers and, for the first time, new digital formats allowed people to access MRC publications on mobile devices.

Specific examples of engagement activities:

National Survey of Health and Development (MRC Lifelong Health and Ageing Unit)
In 2011 participants in the National Survey of Health and Development celebrated their 65th birthday, an event which gained a lot of interest in the media[82] including an editorial in the journal *Nature*.

Executive Committee of the Grand Challenges in Global Mental Health
A consortium of researchers, advocates and clinicians announced research priorities for improving the lives of people with mental illness around the world, and called for urgent action and investment[83]. The Grand Challenges in Global Mental Health is led by the US NIH and the Global Alliance for Chronic Disease. The MRC is represented on the executive committee and several UK, MRC-supported researchers are members of the international scientific advisory board.

FEAST Trial
The FEAST trial (Mortality after fluid bolus in African children with severe infection) won research paper of the year at the 2012 BMJ Group Improving

[82]http://www.nshd.mrc.ac.uk/nshd__65/65th_publications.aspx
[83]Grand challenges in global mental health *Nature* (2011) http://grandchallengesgmh.nimh.nih.gov/Grand%20Challenges%20in%20Global%20Mental%20Health.pdf

Health Awards[84]. The trial confirmed the detrimental effect of fluid in children with the most severe shock and demonstrates the importance of testing interventions for effectiveness in different settings. It serves as a model for future trials in resource poor settings and it is hoped that the trial will avert thousands of deaths a year from the inappropriate use of fluid.

Terrie Moffitt (MRC Social Genetic and Developmental Psychiatry Centre, Kings College London)
The US Public Broadcasting Service featured the Dunedin cohort and E-Risk study in their news hour on 3 June 2011. The television program included footage from the Real Science of Us (a forthcoming TVNZ documentary on the Dunedin Study). Coverage of results on self-control research was in the economic and finance news section of the program, not the medical news section. The program shows how Dunedin and E-risk findings on childhood self-control and adult financial health have now been taken up by SesameStreet to teach children about sound financial planning and policy[85]

Julie Williams (MRC Centre for Neuropsychiatric Genetics and Genomics, University of Cardiff)
In 2011 MRC-funded researchers announced five new genes with a role in Alzheimer's disease, bringing the total number of genes known to increase the risk of developing the disease to ten. The discovery was widely reported in all national newspapers and by the BBC[86].

MRC Clinical Sciences Centre (CSC), Imperial College
The CSC published a book, Suffrage Science, to celebrate the achievements of women scientists and mark the centenary of the International Women's Day. The book was launched in May 2011 with a debate moderated by BBC4 broadcaster Vivienne Parry and involving leading women scientists and artists[87].

[84] BMJ Group Improving Health Awards (2012) http://groupawards.bmj.com/2012%20Shortlist/and-the-winners-are..#research-paper-of-the
[85]'Sesame Street' Tells You How to Get to Sunnier Days Financiallyhttp://www.pbs.org/newshour/bb/business/jan-june11/makingsense_06-03.html
[86]Five more Alzheimer's genes discovered, scientists say (BBC, April 2011) http://www.bbc.co.uk/news/health-12937131
[87]http://www.csc.mrc.ac.uk/PublicScience/FabricsOfLife/SuffrageScience/

Annex 1: New Metrics Framework – BIS 2011/12

Key: =to include | o = optional | = remove

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

		KTE programmes	
KE Programmes		Please State which KE programmes you support	
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)	
Of which University	%		
Of which Wider Public Sector	%		
Of which Third Sector	%		
Of which Private Sector	%		
Of which Unknown or Other	%		
Of which Unemployed	%		
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	

Additional MRC metrics

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

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

Annex 2: MRC metrics

Section 3.1 Income and expenditure							
No.	Metric	Unit	2008/09	2009/10	2010/11	2011/12	Notes
1	Budget Allocation	£m	680.8	722.2	732.0	697.5	As per Annual Report
2	Leverage (MRC definition)	£m	693.7	739.0	745.9	702.1	As per Annual Report i.e. budget allocation (metric 1) plus other income (metric 2c).
2	Leverage (BIS definition)	£m	63.4	77.1	67.6	56.5	As per BIS guidance i.e. external income (metrics 2a, 2b & 2c), excluding that from intellectual property (metric 2d).
2a	of which Private	£m	44.6	50.6	42.5	42.1	
2b	of which from other Research Councils	£m	5.8	9.6	11.2	9.8	
2c	of which from other source – Other Income	£m	13.0	16.9	13.9	4.6	Other income includes sales of laboratory and library services, as well as proceeds from the sales of radioisotopes etc.
2d	of which from other source - Licences and Shares	£m	64.98	66.19	61.69	78.98	Income from IP includes licence income and receipts from sales of shares in MRC companies
3	Total Expenditure	£m	349.6	383.6	384.3	414.1	As per Annual Report
3a	of which Responsive Mode Grant	£m	229.5	249.3	264.5	267.6	As per Annual Report
3b	of which Postgraduate Awards	£m	67.9	78.2	78.7	86.0	As per Annual Report
3c	of which Other components - Other Research	£m	36.9	38.3	23.2	42.2	As per Annual Report
3d	of which Other components - International Subscriptions	£m	15.3	17.8	17.9	18.3	As per Annual Report

Section 3.2 Human Capital (input)							
No.	Metric	Unit	2008/09	2009/10	2010/11	2011/12	Notes
4	Principal Investigators on grants	#	1006	1081	1041	958	Data are expressed in terms of posts at 31 December. 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	#	349	346	289	237	There is a further reduction in the

	Sponsored Institutes						numbers of MRC Programme Leaders and Programme Track Leaders over the last calendar year, similar to last year some of these will be due to the move of MRC Units to University Units, on 1st October 2011 the MRC Human Genetics Unit transferred to the University of Edinburgh.
6	MRC-funded fellows	#	368	362	387	376	Data are expressed in terms of posts at 31 December. This is the number of distinct people: where a person holds more than one grant, they have been counted only once.

Section 4.1 Knowledge Generation										
Paper outputs										
7	Number of Grants assessed for reporting	#	3,841 submitted MRC e-Val returns.							
8	Refereed Publications (publication year)	#	2006	2007	2008	2009	2010	2011	Total	The data gathering period for MRC e-Val in 2011/12 closed in December 2011. The numbers of unique publications submitted by MRC-funded researchers (both intramural and extramural) in 2011/12 are therefore estimated (partial year numbers for reviews 575, articles 5179).
8a	Reviews	#	407	484	615	715	646	767	3634	
8b	Articles	#	3403	4138	4643	5312	5891	6905	30292	
8c	Total	#	3810	4622	5258	6027	6537	7672	33926	
9	Co-authorship of refereed publications - International	#	48% of MRC funded peer reviewed papers published between 2006 and 2011 which have at least one author from outside the UK.							
10	Co-authorship of refereed publications - Industry	#	8.5% of MRC funded peer reviewed papers published between 2006 and 2011 have at least one author from industry.							
Non paper outputs										
11	Collaboration	#	Number of collaborations reported with at least one partner in the relevant sector.							

Sector	Number	%
Academic	6363	59
Public	2434	22
Private	826	8
Non-profit	632	6
Unknown	434	4
Multiple	150	1
Learned society	32	0
Total	10871	100

12 Products or Interventions

#	No year	2006	2007	2008	2009	2010	2011	total
	10	40	24	53	126	152	113 (partial)	518

Type of Products & Interventions	Number	%
Diagnostic Tool - Imaging	36	7.09
Diagnostic Tool - Non-Imaging	96	18.90
Health and Social Care Services	6	1.18
Management of Diseases and Conditions	22	4.33
Preventative Intervention - Behavioural risk modification	26	5.12
Preventative Intervention - Nutrition and Chemoprevention	11	2.17
Preventative Intervention - Physical/Biological risk modification	4	0.79
Products with applications outside of medicine	6	1.18
Support Tool - For Fundamental Research	48	9.45
Support Tool - For Medical Intervention	28	5.51
Therapeutic Intervention - Cellular and gene therapies	24	4.72
Therapeutic Intervention - Complementary	4	0.79
Therapeutic Intervention - Drug	122	24.02
Therapeutic Intervention - Medical Devices	5	0.98
Therapeutic Intervention - Physical	5	0.98
Therapeutic Intervention - Psychological/Behavioural	38	7.48
Therapeutic Intervention - Radiotherapy	1	0.20
Therapeutic Intervention - Surgery	6	1.18
Therapeutic Intervention - Vaccines	20	3.94
Total	508	100

13 Research Materials

#	No year	2006	2007	2008	2009	2010	2011	total
	1430	477	268	384	539	515	416 (partial)	4029

Type of Research Material	Number	%
Antibody	152	3.77
Cell line	227	5.63
Data analysis technique	540	13.40
Database/Collection of Data/Biological Samples	802	19.91
Improvement to research infrastructure	250	6.21
Model of mechanism or symptoms - human	108	2.68
Model of mechanism/symptoms - in vitro	81	2.01
Model of mechanism/symptoms - non-mammalian in vivo	103	2.56
Model of mechanism or symptoms - mammalian in vivo	864	21.44
Other	2	0.05
Physiological assessment or outcome measure	130	3.23
Technology assay or reagent	770	19.11
Total	4029	100

14 Awards and Recognition

#	No year	2006	2007	2008	2009	2010	2011	total
	11	737	840	1249	1673	2150	1861 (partial)	8521

Type of Award & Recognition	Number	%
Appointed to the editorial board of, or advisor to, a journal or book series	1030	12.09
Attracted visiting staff or internships to laboratory	156	1.83
Awarded membership, or a fellowship, of a learned society	796	9.34
Medal	245	2.88
NIHR Senior Investigator/Clinical Excellence Award	105	1.23
Order of Chivalry (e.g.OBE)	41	0.48
Other award	3	0.04
Personally invited as speaker at a conference	3703	43.46
Poster/abstract prize	428	5.02
Prestigious/honorary/advisory position to an external body	987	11.58
Research prize	1027	12.05
Total	8521	100

Section 4.2 Human Capital (stock)

No.	Metric	Unit	2008/09	2009/10	2010/11	2011/12	Notes
15	Number of PhD Students Supported	#	488	460	410	Not yet available	MRC funded students registered on the Je-S system. From a snapshot of JeS data taken in July 2011.
16	Number of Masters Students Supported	See narrative in section 4.2 of main body of report.					
17	Finishing Rates	Approximately 90% Data only shown for records which completed the Je-S submission survey in May 2011. Data is not yet available for 2007 but will be updated in due course.					

Registration year	2004		2005		2006		2007	
	#	%	#	%	#	%	#	%
Within 5 years	326	91.6	394	90.8	286	89.4		
Greater than 5 years	9	2.5%	4	0.9%	0	0.0%		
Delayed submission	6	1.7	9	2.1	25	7.8		
Student will not submit	15	4.2	27	6.2	9	2.8		
Total number of records	356		434		320			

18	Student funding/training schemes	Unit	2008/09	2009/10	2010/11	2011/12	Industry case studentships – funding by academic year.
		£m	3.2	2.5	3.1	3.4	

Section 4.3 Knowledge Transfer and Exchange

19	KE Spend	In 2011/12, 42 translational research awards totalling £34.1m were funded through the boards, Developmental Pathway Funding Scheme (DPFS), Developmental Clinical Studies (DCS), Translational Stem Cell Research Schemes (TSCRS) and panels. Further details of some of these schemes can be found below.

20	KE Programmes	Numbers of awards and total commitment values for some of the MRC translational schemes.

	2008/09		2009/10		2010/11		2011/12	
Scheme	#	£m	#	£m	#	£m	#	£m
Developmental Pathway Funding Scheme (directly managed)	15	6.4	17	8.7	19	12.0	18	11.9
Developmental Clinical Studies	-	-	3	5.3	10	13.7	20	22.3
Translational Stem Cell Research Committee	12	6.4	13	7.3	10	7.6	-	-

Section 4.4 Intellectual Property Activity							
		Unit	2008/09	2009/10	2010/11	2011/12	
21	Patents applications	#	20	25	12	12	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.
22	Patents granted	#	24	29	32	27	
23	Spinouts/new businesses created	#	0	0	2	0	
24	Income from IP activity	£m	64.19	66.17	61.69	78.98	

Section 5.1 Human Capital (flow)		
25	Destination of leavers	The following data show the first destination of PhD students qualifying or completing their courses between 1 August 2008 and 31 July 2011. 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 2010/11. Source: Annabel Clifton Research Councils UK (EPSRC).

Category	2007/08	2008/09	2009/10	2010/11
Engaged in Study	12	19	17	9
Government & Public Sector - not research related	9	19	26	14
Government & Public Sector - research related	6	5	6	4
Higher Education - academic	3	9	7	15
Higher Education - mainly research	70	100	126	125
Higher Education - other	1	4	9	4
Industry & Commerce - research related	3	3	2	4
Industry & Commerce - not research related	11	23	16	27
Not employed	8	23	21	25
Not known or not reported	1	12	9	11
Other Employment	0	1	1	2
R & D Sector Unknown	25	27	49	39
School (Education other)	1	0	0	3
School Teaching or Teacher	1	1	2	1

		Training				
		Self Employed, Voluntary and Unpaid work	2	1	1	2
		Total	153	247	292	285

26	Placements in user organisations	Numbers of Industrial CASE awards over the last four years, these are awarded in partnership with industry or policy making bodies

Unit	2008/09	2009/10	2010/11	2011/12
#	46	34	34	33

In 2011/12 we awarded 15 (out of 33) industrial CASE studentships to SMEs. The industrial partners for all 33 awards in 2011/12 are listed below:

Company	SME?	Number
Autifony Therapeutics Ltd	Y	1
Huntingdon Life Sciences	N	1
Biofocus	N	1
Medpharm Ltd	Y	1
Simcyp Ltd	Y	1
Advion Biosciences Ltd	Y	1
Randox Laboratories Limited	N	1
Janssen Pharmaceutica NV	N	1
Pfizer	N	2
GlaxoSmithKline	N	1
Touchlight Genetics Ltd	Y	1
UCB Celltech	N	1
Astex Therapeutics	Y	1
Okairos	Y	1
Philips Research UK	N	1
Dextra Laboratories Ltd	Y	1
AstraZeneca	N	4
The Binding Site	N	1
Viridian Pharma Ltd	Y	1
Pharmidex Pharmaceutical Services Limited	Y	1
Charnwood Molecular Limited	Y	1
GE Healthcare	N	2
National Physical Laboratory	N	1
MRC Technology	Y	1
F2G Ltd	Y	1
Abcodia Ltd	Y	1
Nutricia Ltd	N	1
Haemostatix Ltd	Y	1

Section 5.2 Public Policy									
27	Instances of Influence on Policy and Practice	#	No year	2006	2007	2008	2009	2010	2011	total
			3	306	233	361	457	449	403 (partial)	2212
28	Instances of influence	Influences on policy setting processes, 1735 reports between 2006 and 2011.								
29	Value/changes induced	Citations in key policy documents, 475 reports between 2006 and 2011.								

Section 5.3 Public Engagement

30 PE Activities

Below is a summary of the data by type of dissemination activity reported between 2006 and 2011.

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	Number	%
Via a formal working group, expert panel or similar	1484	13%
Via a press release, press conference or response to a media enquiry	1237	10%
Via a talk or presentation	4531	39%
Through participation in an open day or visit at my research institute	735	6%
Through participation in an activity, workshop or similar event	2059	18%
In a magazine, newsletter or online publication	1674	14%
total	11720	

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