



Biomedical research - a platform for
increasing health and wealth in the UK

The Academy of Medical Sciences

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Introduction

The relationship between public sector investment in research and economic growth can best be demonstrated in the biomedical sciences. Long-term investment in biomedical science has helped the UK to create one of the most significant and productive sectors in the UK economy after financial services. This paper lays out the relationship between public sector investment in medical research and its impact on wealth and health. If sustained, the UK's increasingly coordinated approach to this scientific arena - delivered through public sector, charitable and commercial partners - is likely to continue to deliver economic benefits.

1 Rebuilding the economy

Groundbreaking advances in medical science over the last 30 years offer the UK unprecedented opportunities to reinvigorate the economy, to maintain and build upon industrial investment in the UK, and to rebuild public finances by making the NHS and public services more productive. Bold leadership will ensure that the UK can continue to generate world-class medical science that is translated into health and wealth benefits. With the right policy choices, the Government can make the UK the best location in the world for medical research across the public and private sectors, attracting vibrant medical science industries and skilled researchers.

The report of the influential US National Academies of Science, 'Rising above the gathering storm', argued that, without high-quality, knowledge-intensive jobs and enterprises, the US economy would suffer from the increasing competition caused by economic globalisation.¹ A similar challenge faces the UK: we now have the opportunity to create more jobs and companies in the biomedical sciences to replace jobs and companies lost in the economic downturn, and to tackle competition from abroad.

Biomedical science and its applications continue to be a major growth sector. Compared to most manufacturing, the biopharmaceutical sector has been less affected by the global recession and is forecast to grow at 5-7% in the years to 2013.² Richer nations spend more on health, meaning that future growth of the world economy will be accompanied by a corresponding expansion in demand for healthcare.³ For example, **private spending on health-related goods and services in China and India is expected to reach 13-14% of household consumption by 2025, substantially higher than in most advanced economies.** These present enormous potential markets for countries that choose to make biomedical science a centre piece of their economies.⁴

Public investment in an excellent science base, together with a strong small and medium biosciences sector, are key factors that keep pharmaceutical companies in the UK. Rising research and development (R&D) costs and falling productivity have prompted the pharmaceutical industry to adopt new business models that have the potential to deliver unique opportunities for the UK.⁵ Large pharmaceutical companies are now investing in flexible partnerships with biotechnology firms and universities to access specialist expertise, as well as to share skills and resources. **By maintaining public sector support for biomedical science, the Government can ensure that the UK is well placed to benefit from a shift that sees global pharmaceutical companies looking to decentralise R&D.**

¹ National Academies of Science (2006). *Rising above the gathering storm: energising and employing America in a brighter economic future*. http://www.nap.edu/catalog.php?record_id=11463

² Department of Business, Innovation and Skills (2010). *Life science in the UK – economic analysis and evidence from 'Life Sciences 2010: Delivering the Blueprint'*. <http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-541-bis-economics-paper-02>

³ Fogel R (2009). *Forecasting the cost of US healthcare*. <http://www.american.com/archive/2009/september/forecasting-the-cost-of-u-s-healthcare>

⁴ Department of Business, Innovation and Skills (2010). *Life science in the UK – economic analysis and evidence from 'Life Sciences 2010: Delivering the Blueprint'*. <http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-541-bis-economics-paper-02>

⁵ Academy of Medical Sciences (2008). *The UK pharmaceutical industry: what does the future hold?* <http://www.acmedsci.ac.uk/p50evid90.html>

To tackle rising public debt and the budget deficit, the UK Government is considering the fiscal consolidation policies applied in countries such as Sweden and Canada during previous recessions.⁶ During the 1990s Canada cut its science budget in half, while Sweden made more modest cuts.^{7,8} However, we emphasise that the composition of the Canadian economy was (and is) markedly different from that of the UK, for instance benefitting from extensive natural resources. Moreover, the USA, the main importer of Canadian goods, was going through a period of significant growth at the time, which helped to bolster Canadian recovery.^{9,10} In drawing lessons from Sweden's recession in the 1990s, the current Swedish Finance Minister has argued that research forms part of the infrastructure that generates future economic growth and should not be subject to public spending cuts.¹¹ **Much can also be learnt from Finland and Korea, where policymakers decided to invest heavily in R&D during times of severely constrained public spending in the 1990s; these investments have been judged to have driven their strong re-growth through building their knowledge economies.**¹² The damage to US stem cell research after the decision to withhold federal funding from this area shows the impact of rapid and substantial drops in funding, and illustrates the sustained scientific advantage that can be gained by competitor countries.¹³

With continued strong support from Government, the UK's unique combination of vibrant biomedical science industries, a unified healthcare system, internationally renowned academic and clinical research centres and a strong talent pool of high quality researchers - as well as the presence of world-class public funders and medical research charities - will make medical science a major catalyst for future UK growth.¹⁴

⁶ HM Treasury (2010). *The budget*. http://www.hm-treasury.gov.uk/d/junebudget_complete.pdf

⁷ The Welsh NHS Confederation (Unknown). *Dealing with national debt – lessons from Canada and Sweden*. <http://www.welshconfed.org/companyData/1898/resources/Canada%20Sweden.pdf>

⁸ Lilico A (2009). *Controlling Spending and Government deficits*. <http://www.policyexchange.org.uk/publications/publication.cgi?id=155>

⁹ Auerback M (2010). *The United Kingdom draws the wrong lessons from Canada*.

<http://www.newdeal20.org/2010/06/09/the-united-kingdom-draws-the-wrong-lessons-from-canada-12009/>

¹⁰ Economist (2010). *The goldilocks recovery*. http://www.economist.com/node/16060113?story_id=16060113

¹¹ Borg A (2010). *Getting fiscal consolidation right: lessons from Sweden*.

http://www2.lse.ac.uk/publicEvents/pdf/20100114_AndersBorg.pdf

¹² Campaign for Science and Engineering. *Securing our economic future with science and engineering*.

<http://www.sciencecampaign.org.uk/documents/2010/CaSEjunebudgetbriefing2010.pdf>

¹³ Drazen JM (2004). *Embryonic stem cell research – the case for federal funding*.

<http://content.nejm.org/cgi/content/full/351/17/1789>

¹⁴ Academy of Medical Sciences (2010). *Reaping the rewards: a vision for UK medical science*.

<http://www.acmedsci.ac.uk/p47prid78.html>

2 Generating exceptional returns for the economy and health

Government support for biomedical research produces substantial economic, health and social rewards. In this section we discuss the economic returns, the value of education and skills, and the social and health dividends gained from medical research.

2.1 Economic returns

A 2008 report commissioned by the Academy of Medical Sciences, Wellcome Trust and Medical Research Council (MRC) demonstrated that **every £1.00 invested in public or charitable research into cardiovascular diseases in the UK between 1975 and 1992 produced a stream of health and economic benefits equivalent to earning £0.39 per year in perpetuity.**¹⁵ Moreover, Medical Research Council (MRC) researchers have been active in the creation or growth of over 30 spin-out companies, which represent hundreds of high value jobs.¹⁶ The huge economic returns from government investment in medical research are highlighted by the story of monoclonal antibodies (see Box 1).

Box 1 Monoclonal antibodies

In the 1970s and 1980s the MRC invested public money in groundbreaking research into monoclonal antibodies. This work earned Drs Cesar Milstein and Georges Kohler the Nobel Prize in 1984 and resulted in the generation of an industry projected to be worth around £16 billion per year in 2010.¹⁷ Sir Gregory Winter CBE FRS FMedSci pioneered the technique to humanise monoclonal antibodies for therapeutic purposes and set up the spin-out company Cambridge Antibody Technology. The company developed these techniques into successful therapeutics, and was sold to AstraZeneca in 2006 for \$702 million. Antibody therapies now constitute a third of all new drugs for a variety of major diseases.

In 2006, the MRC also received more than £7 million as part of GlaxoSmithKline's £230 million acquisition of the antibody company Domantis Ltd – which was founded in 2000 by Sir Gregory Winter and Dr Ian Tomlinson out of the MRC Laboratory of Molecular Biology in Cambridge. Domantis has pioneered methods for the production of the fundamental building blocks of the immune system known as antibody single domains.¹⁸

Pharmaceutical, biotechnology, diagnostics and medical technology companies are a major component of the UK economy, where nearly 30% of GDP is produced by sectors intensive in science, technology, engineering and mathematics (STEM).¹⁹ In 2009 the UK

¹⁵ Health Economics Research Group at Brunel University, Office of Health Economics and RAND Europe (2008). *Medical research: what's it worth?* <http://www.acmedsci.ac.uk/index.php?pid=99&puid=137>

¹⁶ Medical Research Council (2009). *MRC e-Val 2009 survey*. <http://www.mrc.ac.uk/Achievementsimpact/Outputsoutcomes/e-Val/index.htm>

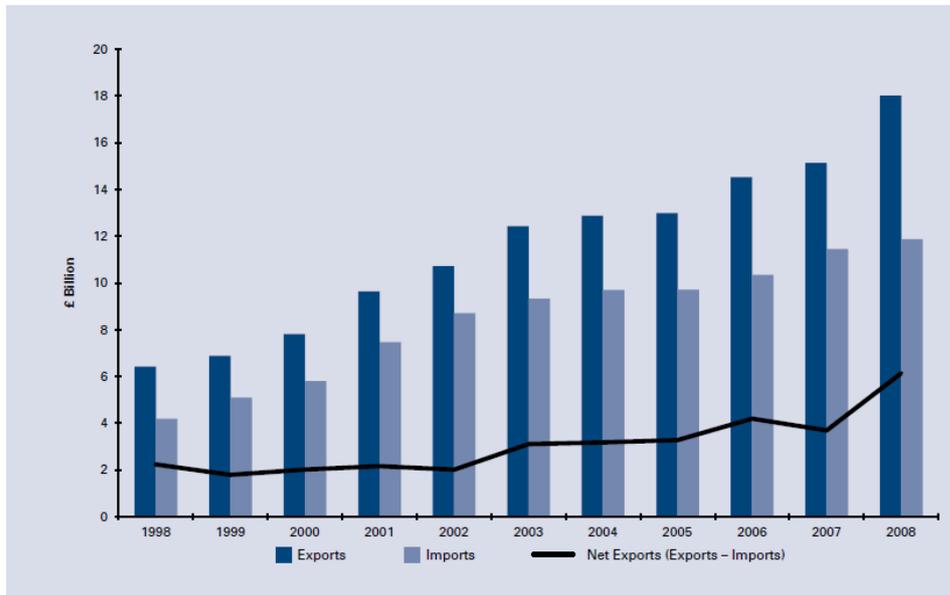
¹⁷ Medical Research Council (2010). *Therapeutic antibodies*. <http://www.mrc.ac.uk/Achievementsimpact/Storiesofimpact/Therapeuticantibodies/index.htm>

¹⁸ *Ibid.*

¹⁹ Campaign for Science and Engineering (2010). *Securing our economic future with science and engineering*. <http://www.sciencecampaign.org.uk/documents/2010/CaSEjunebudgetbriefing2010.pdf>

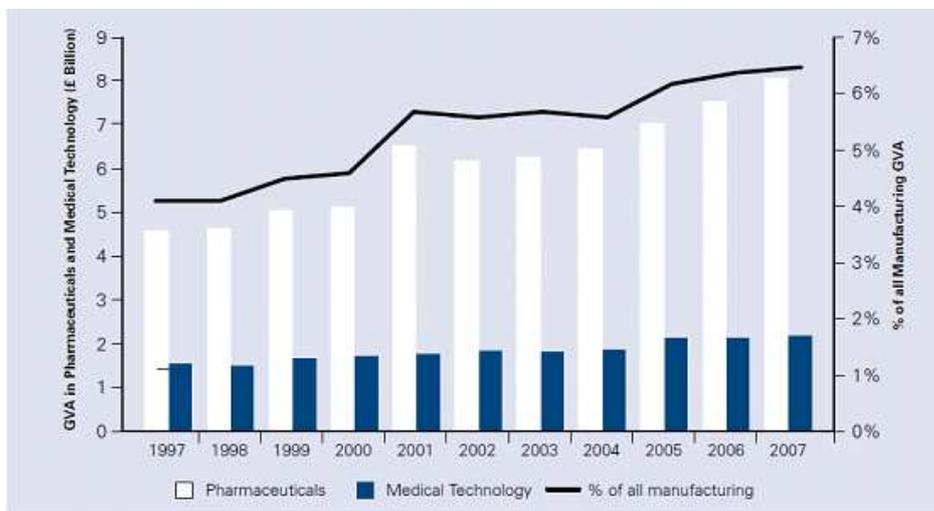
pharmaceutical industry generated a trade surplus of £7 billion.²⁰ The UK trade in pharmaceuticals from 1998-2008 is illustrated in figure 1.

Figure 1: UK trade in pharmaceuticals, 1998-2008²¹



In 2007 the pharmaceutical and medical technology sectors generated around £10 billion in value added, illustrated in Figure 2, and employed over 120,000 people in the UK.²²

Figure 2: Gross Value Added (GVA) in life sciences (nominal terms), UK²³



²⁰ Association of the British Pharmaceutical Industry (2010). *Annual report*.

<http://www.abpi.org.uk/publications/pdfs/AnnualReport0910.pdf>

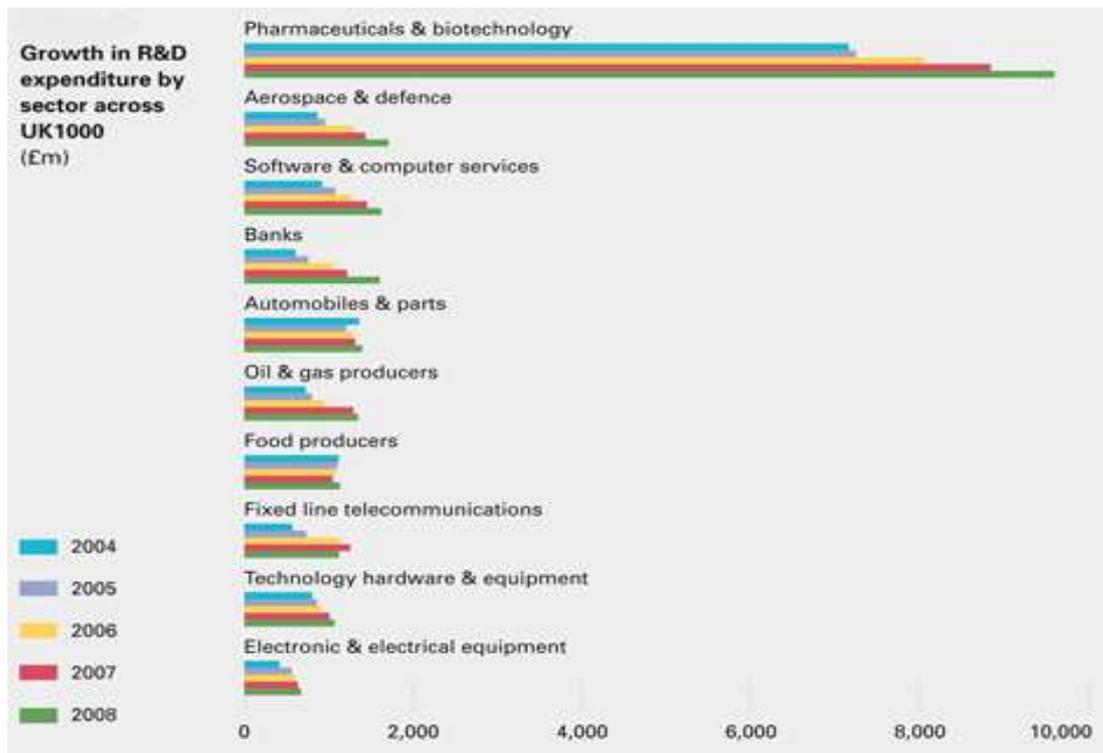
²¹ Department of Business, Innovation and Skills (2010). *Life sciences in the UK – economic analysis and evidence for 'life science 2010: delivering the blueprint'*. <http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-541-bis-economics-paper-02>. With kind permission from the Department, based on data from the Office of National Statistics.

²² *Ibid.*

²³ Department of Business, Innovation and Skills (2010). *Life sciences in the UK – economic analysis and evidence for 'life science 2010: delivering the blueprint'*. <http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-541-bis-economics-paper-02>. With kind permission from the Department, based on data from the Office of National Statistics.

The rise in pharmaceutical and biotechnology R&D investment since 2004 is illustrated in Figure 3. Representatives of the medical science industries stress that one of the major attractions of investment in the UK is the quality of our academic research base, much of which is supported by the public sector and which provides significant spillover benefits for businesses.

Figure 3: Growth in R&D expenditure by sector across the UK 1000.²⁴

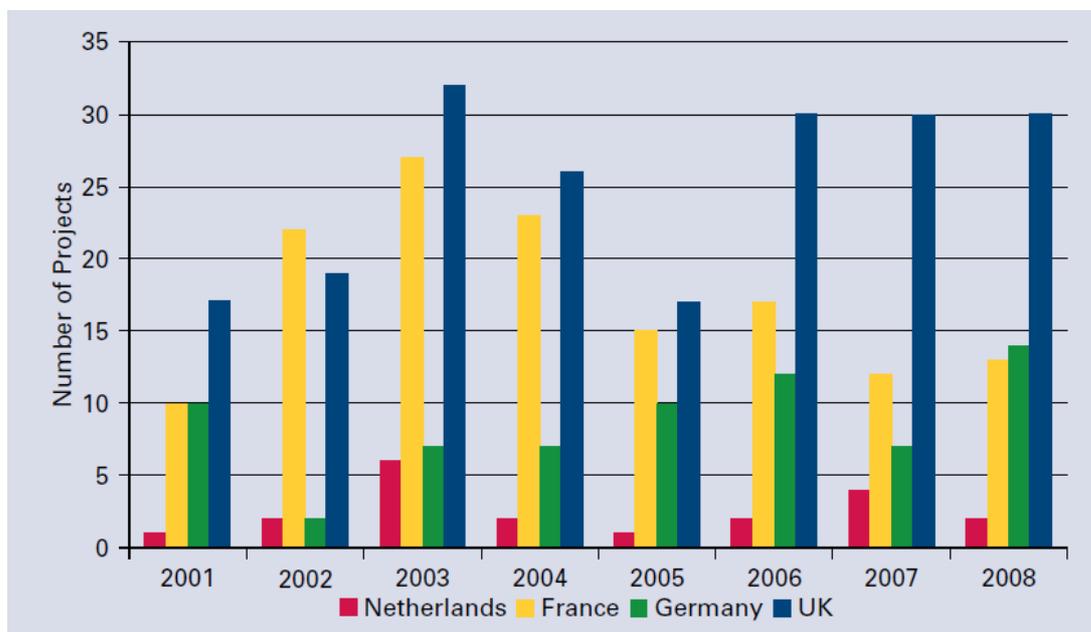


Government support for medical research attracts substantial foreign direct investment that benefits the UK economy. Significantly, the UK attracts almost 10% of the world's pharmaceutical R&D funding.²⁵ Figure 4 compares foreign direct investment in terms of number of new projects in pharmaceuticals in the UK, France, Germany and the Netherlands from 2001 to 2008. The 'take home' message is that countries which develop the right environment for academia, charities, and the pharmaceutical and biotechnology industries will receive substantial inward investment and economic returns.

²⁴ Department of Business, Innovation and Skills (2009). *The R&D scoreboard 2009*. http://www.innovation.gov.uk/rd_scoreboard/?p=18. With kind permission from the Department.

²⁵ Office for Life Science and UKTI (2010). *Life science. The UK collaboration for success*. http://www.uklifescience.co.uk/assets/pdf_files/the-uk-collaboration-for-success/the%20uk%20-%20collaboration%20for%20success.pdf

Figure 4: Foreign direct investment – the number of new projects in pharmaceuticals²⁶



2.2 Education and skills: the foundations of our knowledge economy

The UK's internationally renowned universities make an immense contribution to the economy and themselves attract industry and charities who seek to invest in the UK biomedical science base because of our talent pool and the quality of our research. **Each year the £12 billion invested in UK universities by the taxpayer is transformed into an economic footprint worth almost £60 billion in jobs, exports, innovation and added value.**²⁷ **Over the last decade UK university bioscience departments have generated over 200 spin-out companies that now employ over 1000 people.**²⁸ The sale of the DNA sequencing spin-out company Solexa alone generated \$600 million.²⁹ The strength of our university sector attracted 250,000 overseas students in 2008/09, who contributed about £5 billion to the UK economy.³⁰

Innovation is a non-linear process that involves the iteration of ideas between academia, industry and other sectors. As such, the UK derives significant economic benefit from clustering of leading industries alongside centres of academic research excellence.³¹ For example, work is underway to build a Bioscience Campus in Stevenage, Hertfordshire -

²⁶ Department of Business, Innovation and Skills (2010). *Life sciences in the UK – economic analysis and evidence for 'life science 2010: delivering the blueprint'*. <http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-541-bis-economics-paper-02>. With kind permission from the Department, based on data from the Office of National Statistics.

²⁷ British Academy (2010). *Past, present and future. The public value of the humanities and social sciences*. <http://www.britac.ac.uk/pubs/index.cfm>

²⁸ Royal Society (2010). *The scientific century. Securing our future prosperity*. <http://royalsociety.org/The-scientific-century/>

²⁹ Russell Group (2010). *The economic impact of research conducted in Russell Group Universities*. Russell Group, London.

³⁰ Campaign for Science and Engineering (2010). *Securing our economic future with science and engineering* <http://www.sciencecampaign.org.uk/documents/2010/CaSEjunebudgetbriefing2010.pdf>

³¹ Russell Group (2010). *The economic impact of research conducted in Russell Group Universities*. Russell Group, London.

funded in partnership by the Government, GlaxoSmithKline, the Wellcome Trust, the Technology Strategy Board and the East of England Development Agency (EEDA).³² The project aims to create a world-leading hub for early stage biotech companies. This joint investment by the public, private and charitable sectors recognises that innovation will be a decisive factor in the success of Britain's recovery.

A strong medical research base generates the human capital that is one of the pillars of our knowledge economy. Both the private and public sectors depend on government to provide the education and training required for a skilled workforce. Highly skilled individuals are the UK's most valuable resource, ensuring resilience and enabling our rapid response to future economy recovery.³³ While a PhD can be a gateway to a scientific career, many people with doctorates end up working outside scientific research.³⁴ The skills learnt during their medical research training are of considerable value to other important sectors of the UK economy, such as financial services, the creative industries and public service. There is evidence that employers value a research led education: 50% of graduates from research intensive universities were found to be earning £25,000 or more 3½ years after graduation, compared with just 29% from other institutions.³⁵

2.3 The health and social dividends of medical research

Government support for medical research offers substantial savings by improving public health and preventing disease. Unemployment and sickness absence is estimated to cost the UK more than the entire annual budget of the NHS every year.³⁶ If medical research can mitigate even a fraction of this cost by improving health, then the taxpayer will see a return of many times its original investment. Medical research is essentially the only route to tackle the public health challenges of the future, for instance to address the burden of dementia, the annual cost of which is projected to treble to more than £50 billion over the next 30 years.³⁷

The enormous economic and health dividends of publicly funded medical research are illustrated in Box 2 by the discovery of the link between smoking and lung cancer. Other examples include: research into the effectiveness of Cognitive Behavioural Therapy for treating a range of psychological disorders, which contribute to the estimated £77 billion economic and social cost of mental health in 2002/2003; and understanding of the genetic mutations that cause neonatal diabetes, allowing some patients to come off insulin injections and transfer to tablets, dramatically improving their quality of life.^{38,39,40}

³² BBC (2009). *Bioscience campus scheme unveiled*.

<http://news.bbc.co.uk/1/hi/england/beds/bucks/herts/8305898.stm>

³³ Academy of Medical Sciences (2010). *Second submission to the spending review consultation, July 2010*. Academy of Medical Sciences, London.

³⁴ Royal Society (2010). *The scientific century. Securing our future prosperity*. <http://royalsociety.org/The-scientific-century/>

³⁵ Russell Group (2010). *The economic impact of research conducted in Russell Group Universities*. Russell Group, London.

³⁶ Black C (2008). *Working for a healthier tomorrow*. <http://www.workingforhealth.gov.uk/documents/working-for-a-healthier-tomorrow-tagged.pdf>

³⁷ Foresight (2010). *Mental capital and wellbeing*.

<http://www.foresight.gov.uk/OurWork/ActiveProjects/mental%20capital/ProjectOutputs.asp>

³⁸ Fairburn CG & Hay PJ (1992). *The treatment of bulimia nervosa*. *Annals of medicine* **24(4)**, 297-302.

³⁹ The Sainsbury Mental Health Centre (2003). *The economic and social costs of mental illness*.

http://www.scmh.org.uk/pdfs/costs_of_mental_illness_policy_paper_3.pdf

Box 2 Smoking and cancer

Government support for medical research provides important economic benefits by improving public health and preventing disease. One of the most important examples of this sort of work is the discovery of the link between smoking and lung cancer. This was largely based upon the ground-breaking research of Professor Sir Richard Doll FRS FMedSci and Professor Sir Austin Bradford Hill FRS that was funded by the MRC.^{41,42} It has been estimated that widespread cessation of smoking in the UK since 1950 has approximately halved the mortality from lung cancer that would have been expected if former smokers had continued in their habit.⁴³ The recent ban on smoking in all workplaces and public places in England has provided an estimated net benefit of over £2 billion a year, due to the number of lives saved.⁴⁴ In Scotland in the decade before the ban there was an annual 3% decrease in admissions for heart attacks; in the year following the ban there was a much more substantial fall of 17%.⁴⁵

Recent increases in NHS spending and the current state of the nation's finances make improvements in NHS productivity imperative. One of the most important tools available to Government to raise productivity is medical research, which seeks to improve clinical practice and service design. **Since 2006, publicly funded medical research from the MRC has been cited in over 70 international clinical guidelines, including 15 guidelines issued by the National Institute for Health and Clinical Excellence (NICE).**⁴⁶ One example of the benefits of this sort of research is the finding that compression stockings are unnecessary for those who have had a stroke, which could save the NHS £7 million and 320,000 hours of nursing time each year.^{47,48} Crucially, sustained support through both the science budget (through the Department of Business, Innovation and Skills) and the National Institute of Health Research (NIHR) (through the Department of Health) is needed for medical research to make the NHS more cost effective.

The financial returns of medical research are extraordinary, but it would be misleading to consider the benefits of medical research only through the lens of direct economic impact.⁴⁹ For instance, there is growing recognition of the value of medical research as an instrument of foreign and international development policy. Medical science can

⁴⁰ Wellcome Trust (2006). *The genetic basis of diabetes: improving treatment for patients*. http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_publishing_group/documents/web_document/wtd026674.pdf

⁴¹ Doll R and Hill AB (1950). *Smoking and carcinoma of the lung Preliminary Report*. British Medical Journal **2**, 739-748.

⁴² Doll R and Hill AB (1954). *The mortality of doctors in relation to their smoking habits. A preliminary report*. British Medical Journal **4877**, 1451-55.

⁴³ Peto R et al. (2000). *Smoking, smoking cessation, and lung cancer in the UK since 1950: combination of national statistics with two case-control studies*. British Medical Journal **321**, 323-9.

⁴⁴ Department of Health (2003). *Going smoke free: the economic case. Annual report of the Chief Medical Officer*. http://webarchive.nationalarchives.gov.uk/+/www.dh.gov.uk/en/Publicationsandstatistics/Publications/AnnualReports/Browsable/DH_4875366

⁴⁵ Pell JP et al. (2008). *Smoke-free legislation and hospitalizations for acute coronary syndrome*. The New England Journal of Medicine **359**, 482-491.

⁴⁶ Medical Research Council (2009). *MRC e-Val 2009 survey*. <http://www.mrc.ac.uk/Achievementsimpact/Outputsoutcomes/e-Val/index.htm>

⁴⁷ The University of Edinburgh (2009). *Surgical socks of no use to stroke victims*. <http://www.ed.ac.uk/news/all-news/stroke-010609>

⁴⁸ The CLOTS trials (2009). *Effectiveness of thigh-length graduated compression stockings to reduce the risk of deep vein thrombosis after stroke (CLOTS trial 1): a multicentre, randomised controlled trial*. Lancet **373**, 1958-6.

⁴⁹ Campaign for Science and Engineering (2009). *Impacts of investment in the science and engineering research base*. <http://www.sciencecampaign.org.uk/documents/2009/Impacts.pdf>

strengthen international relations by providing common ground across cultures, improving the health of the world's poorest people, helping to achieve the Millennium Development Goals, building indigenous research capacity, encouraging scientific collaboration and exchange, and tackling international threats such as pandemic infectious diseases or climate change.^{50,51,52}

⁵⁰ The Royal Society (2010). *New frontiers in science diplomacy. Navigating the changing balance of power.* <http://royalsociety.org/New-frontiers-in-science-diplomacy/>

⁵¹ Feldbaum H and Michaud J (2010). *Health diplomacy and the enduring relevance of foreign policy interest.* <http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.1000226>

⁵² Academy of Medical Sciences (2010). *Reaping the rewards: a vision for UK medical science.* <http://www.acmedsci.ac.uk/p47prid78.html>

3 Leading the race to the top

The UK generates over 10% of the world's clinical science and health research outputs, and produces the most scientific citations per researcher in the world.⁵³

Despite the UK's comparative strength in medical science, the future of late stage commercial clinical research in the UK is under serious threat and much activity has already moved abroad. This is illustrated by the UK's proportion of global patient enrolment in clinical trials, which declined from 6% to 2% between 2000 and 2006.^{54,55} The UK's competitors, some of whom have substantial public debt or significant budget deficits, understand the huge potential of medical research to both their economies and public services, and are implementing long-term public investment - over and above short-term stimulus packages - to grow this crucial sector. **The UK currently spends only 0.55% of GDP on R&D – only Italy spends less amongst the G7 countries. French spend is at 0.81% of its GDP, Germany at 0.71% and the USA at 0.77%.**⁵⁶

Following the German Federal elections in September 2009, Chancellor Merkel's government announced that the Federal budget for education and research would rise by around \$15.2 billion by 2013. The goal is to create 'Bildungsrepublik' - an 'educated and learning republic' - to build on Germany's existing strengths in knowledge exchange through the Fraunhofer-Gesellschaft and other intermediary institutions.⁵⁷ Across the Rhine, the French government announced a package worth approximately \$50.5 billion in 2009 to boost the country's economic competitiveness that included around \$11.5 billion for research and around \$15.9 billion for higher education.⁵⁸

Following the spectacular growth in 'low value added' industries, many emerging economies are looking to the future by investing substantially in science, including medical research. For instance, China increased R&D spending by more than 20% year-on-year between 1999 and 2005 and it is now the second largest R&D investor after the USA.^{59,60} In 2004 alone, China produced 6.5 million undergraduates and 500,000 postgraduates in science, medicine and engineering.⁶¹ With the approval of a new fifteen year plan for science and technology in 2006, the Chinese investment is set to increase six fold by 2020.⁶² In 2008, India's Prime Minister Manmohan Singh pledged to open five new Indian Institutes of Science Education and Research, seven new institutes of

⁵³ Department for Innovation, Universities and Skills (2008). *International comparative performance of the UK research base*. <http://webarchive.nationalarchives.gov.uk/tna/+http://www.dius.gov.uk/publications/IntComparativePerformanceUKResearch.pdf/>

⁵⁴ Bioscience Innovation Growth Team (2009). *The review and refresh of bioscience 2015*. <http://www.berr.gov.uk/files/file49805.pdf>

⁵⁵ Office for Life Sciences (2009). *Life science blueprint*. http://www.dius.gov.uk/innovation/business_support/~media/publications/O/ols-blueprint

⁵⁶ Campaign for Science and Engineering (2010). *Securing our economic future with science and engineering*. <http://www.sciencecampaign.org.uk/documents/2010/CaSEJunebudgetbriefing2010.pdf>

⁵⁷ The Royal Society (2010). *The scientific century. Securing our future prosperity*. <http://royalsociety.org/The-scientific-century/>

⁵⁸ Butler D (2009). *French research wins huge cash boost*. *Nature* **462**, 838.

⁵⁹ Leadbeater C and Wilsdon J (2007). *Atlas of ideas: how Asian innovation can benefit us all*. http://www.demos.co.uk/files/Overview_Final1.pdf?1240939425

⁶⁰ The Royal Society (2010). *The scientific century. Securing our future prosperity*. <http://royalsociety.org/The-scientific-century/>

⁶¹ Wilsdon J and Keeley J (2006). *China: the next science superpower?* http://www.demos.co.uk/files/China_Final.pdf?1240939425

⁶² The Royal Society (2010). *The scientific century. Securing our future prosperity*. <http://royalsociety.org/The-scientific-century/>

management and 30 new universities.⁶³ The Indian Government estimated that the pharmaceutical sector could generate revenues of \$22.4 billion in drug development by 2010.⁶⁴ Singapore has one of the fastest growing bioscience clusters in the world after recent government investment of over \$2 billion and substantial recent increases in the output of papers.^{65,66,67} While many of these emerging economies are starting from a low base, the scale of their investment, the size of their populations and the magnitude of their current and future economic growth mean that the UK must invest now to ensure it retains its comparative advantage.

It might be argued that the UK could simply rely on the major research investments being made by other countries, i.e. that we could still reap the rewards of medical research generated overseas even if we have substantially reduced domestic medical research capacity. However, countries with higher domestic R&D intensity, where researchers have developed skills and knowledge in a given area, are significantly better able to exploit the R&D carried out overseas.⁶⁸ In addition, the average 17 year gap between initial expenditure on research and eventual health benefits means that, particularly in the short term, many of the economic benefits of medical science are accrued only by the country that makes the investment.⁶⁹ Even where the research is done outside the UK, we still need to support a flourishing research base to help translate knowledge into products, devices and services that are relevant to our national and local needs.

The UK is now a net importer of scientists and innovators, and these people are more highly skilled than ever before.⁷⁰ Unless we can show a strong and sustained commitment to science and engineering we will be unable to retain and attract the internationally mobile scientists who staff our academic centres and economically valuable medical science industries.⁷¹

⁶³ The Royal Society (2010). *The scientific century. Securing our future prosperity*. <http://royalsociety.org/The-scientific-century/>

⁶⁴ Department of Business, Innovation and Skills (2010). *Life science in the UK – economic analysis and evidence from 'Life Sciences 2010: Delivering the Blueprint'*. <http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-541-bis-economics-paper-02>

⁶⁵ The Economist (2004). *Singapore's man with a plan*. <http://www.economist.com/node/3084417>

⁶⁶ Anon (2008). *Singapore is one of the fastest growing bioclusters in Asia; wave of investments in drug discovery and translational research*. <http://www.newsr.com/article.php?articleID=1265794>

⁶⁷ Department for Innovation, Universities and Skills (2008). *International comparative performance of the UK research base*. <http://webarchive.nationalarchives.gov.uk/tna/+http://www.dius.gov.uk/publications/IntComparativePerformanceUKResearch.pdf/>

⁶⁸ Campaign for Science and Engineering (2009). *Impacts of investment in the science and engineering research base*. <http://www.sciencecampaign.org.uk/documents/2009/Impacts.pdf>

⁶⁹ Wellcome Trust, Medical Research Council and Academy of Medical Sciences (2008). *Medical research: what's it worth? Estimating the economic benefits from medical research in the UK*. <http://www.acmedsci.ac.uk/p99puid137.html>

⁷⁰ The Royal Society (2010). *The scientific century. Securing our future prosperity*. <http://royalsociety.org/The-scientific-century/>

⁷¹ Parliamentary Office of Science and Technology (2010). *International migration of scientists and engineers*. <http://www.parliament.uk/documents/post/postpn309.pdf>

4 Reaping the rewards of recent investment

Medical research has benefited from the recent uplift in public sector investment in health science. As a result of this investment **many UK medical advances are now on the cusp of translation into benefits for patients and society**. Important future opportunities include:⁷²

- Stratified (personalised) medicines: the overall market for which is expected to grow by 5% per annum to reach \$50 billion by 2012.
- Regenerative medicines: the tissue engineering and regenerative medicine market was estimated at \$8.5 billion in 2008 and could grow to \$118 billion by 2013.
- Stem cells: The stem cell therapeutics market is largely untapped and currently estimated at around \$87million but has been predicted to increase to as much as \$8.5 billion over the next decade.

If these opportunities are not realised now by the UK then some will disappear abroad - as happened with much of the UK's semiconductor industry - and others may be lost altogether.⁷³

The landscape of UK medical research has recently been transformed by several initiatives aimed at increasing the economic benefits of publicly funded medical research. The formation of the Office for the Strategic Coordination of Health Research (OSCHR) has made UK health research more coherent by coordinating the strategies of the MRC, NIHR and NHS research offices in the Devolved Administrations. A major success of the OSCHR process has been in building momentum for the translational research agenda and strengthening clinical research in the NHS through initiatives such as new UK Life Science Supercluster and Therapeutic Capability Clusters (Box 3). The establishment of the NIHR with its ring fenced budget has created a sustainable and strong base for research within the NHS and has provided a significant boost to UK medical science. In addition, the Technology Strategy Board has an increasingly important role in driving innovation. Government can further enhance research by creating a more conducive policy and regulatory environment that will attract investment by industry and charities. The Academy's forthcoming review of medical research regulation and governance will be making explicit recommendations in this area.⁷⁴

⁷² Department of Business, Innovation and Skills (2010). *Life science in the UK – economic analysis and evidence from 'Life Sciences 2010: Delivering the Blueprint'*. <http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-541-bis-economics-paper-02>

⁷³ House of Commons Science and Technology Selection Committee (2010). *The impact of spending cuts on science and scientific research*. <http://www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/335/335i.pdf>

⁷⁴ Further information is available from: <http://www.acmedsci.ac.uk/p47prid80.html>

Box 3 The Life Sciences Supercluster and Therapeutic Capability Clusters⁷⁵

In July 2009, the Government published the *Life Sciences Blueprint*, a comprehensive package of high-impact measures to support economic growth and strong healthcare delivery. One measure is to support the formation of a UK Life Sciences Supercluster. Public funders and industry have been working together to develop a concept that will capture and promote the UK's world leading capability in translational research, deepen academic-NHS-industry collaboration, enable the UK to function as a global leader on the international stage, and encourage global industry collaboration with UK health research centres.

The vehicle for achieving these aims will be a series of Therapeutic Capability Clusters in areas of substantial health burden and unmet medical need. The Capability Clusters will focus on areas of translational medicine, particularly early clinical studies, where industry has a strong interest in working with academia and where both the public (NHS and academic) and private (life sciences industry) sectors will gain by working closely together.

The first of these Therapeutic Capability Clusters will be in the area of Inflammation and Immunity, with two pilot clusters in inflammatory respiratory diseases and joint and related inflammatory diseases, where there is existing academic excellence and where the cluster can draw on existing capability.

Medical science is a long-term endeavor that requires sustained funding. Areas of research that are halted before they can deliver outputs represent wasted investment. Moreover, subsequent loss of staff and expertise mean that projects and research areas cannot easily be resumed if funding subsequently becomes available. The example of radiotherapy considered in Box 4 clearly demonstrates the negative impact of long term underfunding.

Box 4 Radiotherapy – turning the ship around

Radiotherapy is a major treatment for cancer patients and is thought to be involved in 40% of cases where cancer is cured.⁷⁶ In 2003 the National Cancer Research Institute found radiobiology research in the UK in a state of decline, with the number of people active in the field nearing the point where it would no longer be sustainable as an academic discipline.⁷⁷

A lack of scientific supervisors and few post doctoral positions meant that many young researchers had no option but to leave the country or to choose an alternative research discipline. If this pattern continued there would be no radiotherapy-based academics in

⁷⁵ Medical Research Council, National Institute of Health Research, HSC Public Health Agency, Welsh Assembly Government, Technology Strategy Board and Chief Scientist's Office (2010). *Call for initial applications: therapeutic capability clusters in inflammatory respiratory disease and joint and related inflammatory disease*. http://www.nihr.ac.uk/about/Pages/Office_for_Life_Sciences_call.aspx

⁷⁶ Cancer Research UK (2009). *What radiotherapy is*. <http://www.cancerhelp.org.uk/about-cancer/treatment/radiotherapy/about/what-radiotherapy-is>

⁷⁷ National Cancer Research Institute (2003). *NCRI report of the radiotherapy and related radiobiology progress review group*. <http://www.ncri.org.uk/default.asp?s=2&p=4>

this country within 10 years. The sharp decline in radiobiology experts, including clinical academics and radiation biologists, was due to progressive reductions in support for radiobiology and radiotherapy research over 15 years from the late 1980s.

Nearly ten years on since the decision by charities, government and industry to repair the dire state of radiobiology research in the UK; there is still a great deal of work to be done. This is a clear demonstration of how long it can take to turn the ship around, if there is a sharp reduction in support for an important area of research.

5 Sustaining our science and innovation ecosystem

One of the UK's strengths is its rich landscape of medical research funders. The UK is home to uniquely strong medical research charities, which together contribute one third of non-commercial spending on medical research – about £1.1 billion in 2008.⁷⁸ We are also ranked second in the world in terms of the proportion of people that have reported giving to fundraising campaigns.⁷⁹ On the commercial side, in 2007 the pharmaceutical industry invested £4.3 billion in R&D in the UK.⁸⁰

It is important to emphasise that public spending on the science budget leverages - rather than displaces - private and charitable funding.⁸¹ A recent study showed that **every £1 increase in public funding stimulates up to £5 investment into research by the pharmaceutical industry.**⁸² Moreover, one survey showed that 10% of all new products and services developed by companies could not have been developed - without significant delay - without university research.⁸³ The leveraging effect of public investment on industry and charities is illustrated in Box 5 by the MRC Protein Phosphorylation Unit at Dundee University and the collaboration that created Flexi Scope, a diagnostic screening test for bowel cancer.

Charities are seen as an increasingly important component of medical research collaborations, capable of drawing in further funding, additional partners and patient support. They also play an important role in making science and the process of discovery, open and transparent to the public. Medical research charities have played a pivotal role in advancing science that will pay significant social and economic dividends, these include:

- The recent discovery of a potential biomarker for dementia (Alzheimer's Research Trust).⁸⁴
- The development of anti-TNF therapy for rheumatoid arthritis, discussed in box 6 (Arthritis Research UK).⁸⁵
- The development of statins that reduce the risk of heart attack (British Heart Foundation).⁸⁶
- The human genome project (Wellcome Trust).⁸⁷

⁷⁸ Association of Medical Research Charities (2010). *To the public - 'thank you'*. http://amrc.org.uk/tabs_news-2010_thanks-to-donors

⁷⁹ *Ibid.*

⁸⁰ Association of the British Pharmaceutical Industry (2010). *Annual report*. <http://www.abpi.org.uk/publications/pdfs/AnnualReport0910.pdf>

⁸¹ Royal Society (2010). *The scientific century: securing our future prosperity*. <http://royalsociety.org/the-scientific-century/>

⁸² Alzheimer's Research Society (2009). *Forward together. Complementarity of public and charitable research with respect to private spending*.

<http://www.alzheimers-research.org.uk/assets/docs/20090917162138ForwardTogetherSep2009.pdf>

⁸³ Russell Group (2010). *The economic impact of research conducted in Russell Group Universities*. Russell Group, London.

⁸⁴ Further information is available from: <http://www.alzheimers-research.org.uk/aboutus/achievements/>

⁸⁵ Further information is available from:

http://www.arthritisresearchuk.org/about_us/our_achievements_so_far.aspx

⁸⁶ Further information is available from:

http://www.bhf.org.uk/research_health_professionals/research_successes/statins.aspx

⁸⁷ Further information is available from: <http://www.wellcome.ac.uk/Achievements-and-Impact/Major-achievements/Human-genome/index.htm>

Box 5 Leveraging investment from industry and charities

The MRC Protein Phosphorylation Unit (PPU) at the University of Dundee

In 1996, Sir Philip Cohen FRS FMedSci sought support from the pharmaceutical industry when establishing the Division of Signal Transduction Therapy (DSTT), now known as the PPU. The aim of the PPU is to develop research into protein phosphorylation, a key regulatory mechanism in biology, which is often abnormal in diseased states. The partnership includes academics from Dundee University, alongside funding from the MRC, AstraZeneca, Boehringer Ingelheim, GlaxoSmithKline, Merck & Co Inc, Merck KGaA and Pfizer. In 2008, after a renewal of core funding, the PPU has raised £23 million of private investment into the unit.⁸⁸

Research in this area is of great importance, considering that in 2009 drugs which act on kinases had a market worth of \$15.2 billion – a market that is projected to grow by a third to over £20 billion by 2014.⁸⁹ The collaboration is thought to be the largest of its kind in the UK and allows for the sharing of reagents, technology, unpublished results and the right to license the intellectual property generated. This unique environment is possible because central funding from the MRC leverages further investment from the private sector.

Flexi Scope: saving lives and money through collaborative research

MRC research, published in April this year, has shown that a new method for bowel screening could prevent at least 5,000 people from being diagnosed with bowel cancer and save at least 3,000 people from dying from the disease each year in the UK.⁹⁰ Given that bowel cancer is the third most common cancer (38,500 cases per year) and the second biggest cancer killer in the UK (16,000 deaths per year), these are important results.

Flexible sigmoidoscopy screening, or 'flexi scope', has been developed by the Population and Screening Research Group at Imperial College London, who have a long history of research in this area. The success of the initiative has relied on core support from Cancer Research UK, supplemented by government, research council, and private research grants. The flexi-scope test is a highly effective intervention and has the potential to be cost-saving for the NHS.⁹¹

⁸⁸ Medical Research Council Protein Phosphorylation Unit (2010). *UK's pioneering pharmaceutical collaboration attracts £10.8 million funding.*

http://www.ppu.mrc.ac.uk/news_and_seminars/mrc_unit_news.php?year=2008&month=August

⁸⁹ Lawler B (2009). *Kinase inhibitors: global markets.* <http://www.bccresearch.com/report/BIO053B.html>

⁹⁰ Cancer Research UK (2010). *New study marks major advance in bowel cancer screening.*

<http://scienceblog.cancerresearchuk.org/2010/04/28/new-study-marks-major-advance-in-bowel-cancer-screening/>

⁹¹ *Ibid.*

Box 6 Anti-TNF

Pioneering basic research and clinical trials led by UK scientists Professor Marc Feldmann FRS FMedSci and Professor Sir Ravinder Maini FRS FMedSci have transformed the treatment of rheumatoid arthritis and other inflammatory conditions. Investigations into the biochemical mechanisms underpinning inflammation revealed the central role of Tumour Necrosis Factor (TNF) in driving the disease process. A monoclonal antibody was then used to block TNF. This led to the development of several anti-TNF drugs, one of which, Humira®, has worldwide sales of around \$5.6 billion in 2009.⁹² Much of the research that led to the development of anti-TNF drugs was supported by the charitable sector, as well as the public sector and industry, demonstrating the significant health and economic impact of research funded in this way.

Charities are attracted to investing in UK medical research because it represents good value and is highly competitive in terms of the quality and excellence of the science. As with industry, medical research charity funding relies on a strong, publicly funded research base and infrastructure to achieve its aims. **Without the incentive of UK public sector support, some the £1.1 billion annual spend by UK medical research charities could be refocused on to other topics or be invested abroad.**⁹³ Public spending on medical research also attracts investment from foreign charities and other international research funders. For instance the UK received around \$3 billion from European Framework Programme 6 – more than any other country and the most number of European Research Council grants between 2007 and 2009.^{94,95} The Gates Foundation, the world's largest charity, recently established an office in the UK in part because of the excellence of our research base in malaria, tuberculosis and HIV.

This medical science and innovation ecosystem of government, industry and charities is highly productive, yet relatively delicate. Charity, industry and public funding tends to focus on different but complementary, areas of research, and it is therefore a mistake to believe that industry and charities could simply fill the gap if public sector funding was reduced.⁹⁶ The strength of the research system as a whole depends on its constituent parts, and crucially, on the relationship between them.⁹⁷ Substantial reductions in government support for the science budget are therefore likely to have negative and unpredictable consequences for the private and charitable sectors. One example of the symbiosis between the public sector, charities and industry is given in Box 7.

⁹² Evaluate pharma (2010). *Humira set to steal avastin's crown*.

<http://www.evaluatepharma.com/Universal/View.aspx?type=Story&id=211976&isEPVantage=yes>

⁹³ Association of Medical Research Charities (2010). *To the public – 'thank you'*. http://amrc.org.uk/tabs_news-2010_thanks-to-donors

⁹⁴ Parliamentary Office of Science and Technology (2010). *EU science and technology funding*.

<http://www.parliament.uk/documents/post/postpn359-eu-science-funding.pdf>

⁹⁵ Royal Society (2010). *The scientific century: securing our future prosperity*. <http://royalsociety.org/the-scientific-century/>

⁹⁶ Academy of Medical Sciences. *Second submission to the spending review consultation, July 2010*. Academy of Medical Sciences, London.

⁹⁷ Royal Society (2010). *The scientific century: securing our future prosperity*. <http://royalsociety.org/the-scientific-century/>

Box 7 Manchester: strength through collaboration

Cancer research conducted in Greater Manchester is a prime example of how vital public funding is in leveraging significant investment from other funders. The Manchester Cancer Research Centre (MCRC) is a multi-million pound partnership between the University of Manchester, the Paterson Institute, the Christie Hospital, and Cancer Research UK. The MCRC is now a world-class centre of excellence in cancer research, with ambitions to more than double its activity by 2015.⁹⁸

Key enablers behind this success are: the quality related (QR) funding received by the University from HEFCE; the support funding that the Christie Hospital receives from the NHS; and the infrastructure funding that the Paterson Institute receives from the Christie Hospital Endowment Fund. This support, and the freedom for institutions to direct this strategically, contributes the facilities and personnel that are vital for high quality cancer research. AstraZeneca's strategic alliance in Manchester provided investment to the sum of £2.12 million in 2008. The company cites the willingness of the MCRC to work with industry as key a factor in its continuing investment at Alderley Edge – which was chosen as one of three research sites in Europe, out of a total 27 sites considered.⁹⁹ Additional funding bodies, including smaller more specialist charities and companies, have also been attracted to the concentration of expertise and infrastructure in Manchester.¹⁰⁰

The collaboration at Manchester simultaneously supports the health of the community, whilst providing significant employment and technical training for people within the local area. This dynamic partnership model is mirrored across the university, with Manchester attracting over £273.6 million of external funding in 2008.¹⁰¹ The University is now one of the largest employers in Greater Manchester, with more than 5,800 academic and research staff.¹⁰²

⁹⁸ The University of Manchester, Manchester Cancer Research Centre (2010). *Our goals*. <http://www.mcrc.manchester.ac.uk/ambition/goals.htm>

⁹⁹ Personal correspondence, Cancer Research UK.

¹⁰⁰ For example the charity Breakthrough Breast Cancer funds the Breakthrough Breast Cancer Research Unit. The unit, officially opened in March 2010, is based within the MCRC. <http://www.breastcentre.manchester.ac.uk/breakthrough/press.html>

¹⁰¹ The University of Manchester (2010). *Facts and figures 2010*. <http://documents.manchester.ac.uk/display.aspx?DocID=6178>

¹⁰² The University of Manchester (2009). *The University of Manchester annual review 2008-2009*. <http://documents.manchester.ac.uk/display.aspx?DocID=4387>

Conclusion

The decisions made in the forthcoming Spending Review will determine whether the UK can harness the rich opportunities offered by medical science to improve health and wealth for the benefit of patients and society. If properly supported, medical research will create new jobs, catalyse sustained economic growth and help to restore public finances by improving health and by making the NHS and public services more cost effective. In contrast, substantial cuts in medical research spending would be counter-productive, undermining a prime source of the economic growth that is needed to recover from the financial downturn. **A recent survey found that 95% of respondents thought that medical research should be supported and encouraged, even if a lot of public money would need to be invested.**¹⁰³ Government should respond to this chorus of public opinion by placing medical research at the heart of its economic agenda.

¹⁰³ Wellcome Trust (2010). *Wellcome Trust Monitor 1. Tracking public views on medical research*. http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_grants/documents/web_document/wtx058862.pdf



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