13 CONTRIBUTION TO HEALTH

The University of Oxford is the top ranking institution in the UK for medical research and carries out a wide range of research related to health issues. The University of Oxford has a strong heritage in medical research advancements, including the discovery of penicillin and the treatment of hypoxia. There are a wide range of activities across many departments in the University that contribute towards improved public health outcomes, however the majority of this activity occurs within the Medical Sciences Division. In 2014/15 the Medical Sciences Division at the University of Oxford received £340 million in research funding.

Medical sciences is only one example of areas of Oxford research that have a broad and deep economic impact. Others are discussed elsewhere in this report. This section focuses on medical sciences because it is one of the University of Oxford's strengths and because it is an area where there is a good existing evidence available that demonstrates how the research inputs deliver economic impacts.

13.1 University of Oxford Medical Sciences Division

The Medical Sciences Division at the University of Oxford is the highest ranked clinical, pre-clinical and health department in the world[47]. It has held this position since 2011 and its overall score in the Times Higher Education (THE) ranking system has increased steadily since 2013. The University of Oxford performs particularly well in the quality of its research, which in turn has resulted in it receiving a higher score on income from industry than any other medical school in the world.

Table 13.1 – University of Oxford MSD THE Performance Breakdown 2016

Year	Rank	Teaching	International Outlook	Research	Citations	Industry Income	Total
2016	1	85.3	83.2	98.0	98.4	99.9	93.7
2015	1	87.4	81.8	91.9	98.0	99.9	92.3
2014	1	86.8	81.3	92.0	97.6	100.0	91.9
2013	1	85.0	81.5	91.0	99.2	100.0	91.7
2012	1	89.1	85.6	90.8	99.9	96.9	93.3
2011	4	88.4	60.6	88.3	99.0	59.3	90.2

Source: Times Higher Education

The Medical Science Division has over 5,500 members of staff including, researchers, academics, NHS clinicians and administrative staff. There are 3,000 students who study within the division.

13.1.1 Research

The University of Oxford's clinical, pre-clinical and health research has huge impact on the healthcare sector and the health of patients. This research has helped the UK to become a global leader in healthcare related research and the Strategic Plan[48] of the University highlights the need for continual developments in its research programme to reinforce this position.

[47] Times Higher Education
[48] University of Oxford (2013) Strategic Plan 2013 - 18

The medical research activity at the University of Oxford accounts for more than half of all research income to the University and almost 70% of all external research funding. The scale of the medical research activity that is undertaken means that the scope of the studies are not limited to particular areas of specialism, as would be found at a smaller University. The wide scope of research strengths within the University of Oxford enable it to tackle both national and international health priorities.

13.1.1.1 National Health Priorities

The medical research that is undertaken at the University of Oxford addresses many of the health research priorities of the UK, particularly those associated with its ageing population. The National Institute for Health Research (NIHR) has identified Dementia and Antimicrobial Resistance as the two main priorities for the NHS to tackle through research. These issues represent a significant future cost burden to the NHS and health burden to the population. Both of these issues are tackled through research at the University of Oxford.

The Oxford Dementia and Ageing Research (OXDARE) consortium is a multidepartmental group of scientist and clinicians who are working on various aspects of translational dementia and ageing research. In particular this consortium is focused on:

- epidemiological, clinical, neuropsychological and neuropharmacological assessment of cognition in aging and dementia;
- multimodal structural and functional brain imaging and analysis, including magnetic-resonance imaging and magnetoencephalography; and
- patient-driven induced pluripotent stem cell neuronal models of neurodegenerative disease for drug discovery.

The research at the University of Oxford into Antimicrobial Resistance takes place across multiple departments and in collaboration with other universities. Some of this research has created new treatments to combat the spread of Antimicrobial Resistance, including the use of rhoadanine based inhibitor ML302, to selectively target bacterial metallo-beta-lactamases. This technology is now at the stage of being of interest to commercial biomedical companies and Oxford University Innovation have filed a patent application to be able to licence this discovery.

The medical research at the University of Oxford covers a wider range of priorities than those specified by the NIHR. These research outcomes contribute to the Research Excellence Framework (REF) submissions by the University of Oxford, including research into rheumatoid arthritis and knee replacement, which are discussed in Figure 13.1 and Figure 13.2. The results of the REF found that the majority of medical submissions by the University of Oxford was of the highest standard, including:

- Clinical Medicine, in which 94% of research was either 'world leading' or 'internationally excellent';
- Public Health, Health Services and Primary Care in which 92% of research was either 'world leading' or 'internationally excellent';
- Psychology, Psychiatry and Neuroscience, in which 95% of research was either 'world leading' or 'internationally excellent'; and

- Biological Sciences, in which 93% of research was either 'world leading' or 'internationally excellent'.

Figure 13.1 – REF Case Study: Revolutionising the Treatment of Rheumatoid Arthritis[49]

Professor Marc Feldmann and Professor Ravinder Maini of the Kennedy institute, which is now located the University of Oxford, undertook research in the 1980s and 1990s into drugs which target tumour necrosis factor (TNFα). The research that they undertook showed that these therapies led to dramatic improvements in patients with rheumatoid arthritis, especially in conjunction with therapy targeting T cells, and, following commercialisation in 1998, these drugs have set the gold standard for pharmalogical management of rheumatoid arthritis. They have also been effective in treating Crohn's disease and other immunological diseases.

Rheumatoid arthritis is a persistent inflammatory arthritis of synovial joints and affects over 500,000 people in England, and many more worldwide. Since their development anti-TNFα therapies have become the standard treatment for rheumatoid arthritis, helping to protect joints from damage, and has been used on over 2 million patients. They supported pharmaceutical sales worth over $30 billion in 2015, including Humira, the most valuable drug in the world. [50]

13.1.1.2 Global Health: Vaccine Development

The World Health Organisation has identified infectious diseases, such as malaria, as one of the main priorities for medical research globally and "halting and beginning to reverse the global incidence of malaria by 2015" was one of the Millennium Development Goals. In 2015, there were an estimated 214 million new cases of malaria that puts a significant economic burden on the healthcare systems of affected countries and their economies through reduced workforce productivity. Although it does affect the UK population, as the leading global University for medical research, the University of Oxford is playing an important role in tackling this disease.

In the 1980s Professor Nick White of the University of Oxford began to develop and research the malaria drug artemisinin, after Chinese researchers discovered that wormwood, from which artemisinin was originally derived, was capable of treating malaria. Professor White's team tested the relative effectiveness of different strains in treating malaria.

In a five year study beginning in 1990 they demonstrated that the best available way of treating malaria was through artemisinin-combination therapy (ACT), which combine artemisinin with chloroquine, a synthetic form of quinine. Subsequent research, including a landmark 2005 paper, found that ACT was safer, simpler and more effective than conventional treatments and significantly reduced mortality amongst both adults and children.[51]

As a result of its proven track record of treating malaria, ACT has become the WHO's recommended treatment for malaria, and is the first-line treatment in 81 of the 95 countries to which malaria is endemic. In 2014, there were 337 million ACT

[49] REF (2014), Revolutionising the treatment of rheumatoid arthritis
[50] Pharmacompass (2016), Top drug sales by revenue 2015. http://www.pharmacompass.com/radio-compass-blog/top-drugs-by-sales-revenue-in-2015-who-sold-the-biggest-blockbuster-drugs
[51] REF (2014), Introducing Artemisinin to the World

treatment courses administered, compared to 11 million in 2005, and 158 million in 2009.[52]

This, along with better prevention and awareness, has helped to reduce the mortality rate among those suffering from malaria by 60% since 2000. Additionally, malaria incidence among at risk populations fell by 37% between 2001 and 2015. These factors together have averted an estimated 6.2 million deaths globally, of which 21% were due to ACT.[53]

This is significant because malaria, as well as having severe negative health effects, has a strongly detrimental effect on growth, through the direct costs of health care, but also from lost productivity. Economists have estimated that this could have a growth penalty for the worst affected countries of 1.3% annually. This leads to substantial differences in growth over the long term[54].

The University of Oxford's role in combatting malaria goes beyond the development of ACT. In order to counteract the effects of the disease it is also necessary to have health care structures, and appropriate prevention measures such as nets. Research by the University of Oxford has underpinned the WHO's policy shift toward providing insecticide treated nets free of charge, by demonstrating how they can significantly reduce the incidence of malaria.[55]

One of the areas that the University of Oxford has been most instrumental is in ensuring that funding is targeted to generate the most significant impact. Through the Malaria Atlas Project (MAP), which uses a combination of epidemiological, geographical and demographic data, can provide information on the regional endemicity of malaria, and is the 'gold standard' for malaria mapping. MAP data, which also provides data on the prevalence of dengue fever, is used extensively by the WHO, as well as other members of the Roll Back Malaria Partnership such as UNICEF, the UN Development Programme and the World Bank.[56]

Additionally, research at the University of Oxford has provided evidence of the effectiveness of typical malaria treatments in reducing malaria prevalence among pregnant women, which is responsible for 10,000 maternal deaths and up to 8% of all infant deaths each year, although less than 5% of women have access to effective interventions. This evidence, which demonstrated that treatments had no negative side effects for pregnant women, led the WHO to make significant changes to its treatment guidelines for pregnant women.[57]

As well as developing new medicines, the University of Oxford's research has exposed the scale of the trade in counterfeit antimalarial drugs, which may have been responsible for thousands of deaths. This led the WHO to set up minilabs, were screening can be carried out, as well as criminal investigations and arrests through INTERPOL.[58]

However, University of Oxford research has also found that artemisinin resistance is developing in mosquitoes, particularly in Western Cambodia and on the Thailand-

[52] WHO (2016), Overview of Malaria Treatment. http://www.who.int/malaria/areas/treatment/overview/en/
[53] WHO (2016), World Malaria Report 2015
[54] Roll Back Malaria, Economic Costs of Malaria
[55] REF (2014), Knowledge is Power: Informing National Governments in the Global Fight Against Malaria
[56] REF (2014), Mapping vector0borne diseases to inform global planning for control and elimination
[57] REF (2014), Malaria Treatment in Pregnancy
[58] REF (2014), Exposing a Murderous Trade

Myanmar border, although this is partly due to artemisinin only therapies, rather than artemisinin-combination treatments. Given this, and the likelihood of increasing malaria resistance new and improved methods of defeating the disease are necessary[59].

Professor Luke Alphey of the University of Oxford's Department of Zoology and Oxitec, a spin-out company, have been developing a gene-modification technology that could significantly reduce or eradicate mosquito populations through the Sterile Insect Technique (SIT). This involves removing specific genes from an insect (which has been made dramatically simpler by a precise gene-editing tool called CRISPR), which causes any offspring to die.

Although this research is primarily focused on the *Aedes Aegypti* species of mosquito, which carries dengue fever, yellow fever and most recently Zika virus, the research is highly significant in attempts to reduce malaria for two reasons: it demonstrates the effectiveness of the technology; and it has encouraged the development of a regulatory framework.[60]

In field trials up to 96% of the mosquito population has been eradicated, following the deployment of Oxitec's genetically modified (GM) mosquitoes. This has led to deployment in certain areas of Brazil, where the Zika virus has been especially prominent, and construction of a factory, which can produce 60 million GM mosquitoes per week.[61]

Furthermore, as a result of the pace of development, regulatory bodies such as the WHO, the European Food Standards and Authority and the United States Food and Drug Authority, have issued regulations and guidance on the subject of GM mosquitoes.[62] As this technology has the potential to wipe out entire species, it has proven highly controversial. However, the work of Oxitec could pave the way for GM mosquitoes being deployed elsewhere in the world, and specifically targeting mosquitoes that carry malaria.

13.1.2 Collaboration with the NHS

The NHS is the largest provider of healthcare services in the UK and the University of Oxford Medical Sciences Division has a strong working relationship with it. This includes a partnership with local hospitals to facilitate teaching, research and care. Oxford University Hospitals NHS Trust (OUH) is a Foundation Trust consisting of four hospitals that are linked with the University of Oxford. In 2014/15, the Trust:

- had a turnover of £916 million;
- employed 12,163 staff;
- served a population of 805,000 people; and
- provided 1 million patient contacts.

[59] REF (2014), Alerting the World to Artemisinin Resistance
[60] REF (2014), An innovative GM approach to the control of insect pests and mosquito vectors of human disease
[61] Phys.org (2016), Brazil mutant mosquitoes to breed out diseases. http://phys.org/news/2016-10-brazil-mutant-mosquitoes-diseases.html
[62] USFDA (2016), FDA Releases Final Environmental Assessment for Genetically Engineered Mosquitoes http://www.fda.gov/AnimalVeterinary/NewsEvents/CVMUpdates/ucm490246.htm

The John Radcliffe Hospital is the largest in the Trust and is the main centre for clinical teaching of medical students at the University of Oxford.

The OUH also plays an important role in the ability of the University of Oxford to undertake medical research, throughout the development process of new technologies and treatments. The OUH supports patients who are able to participate in research studies that are being run by the University and lists the current studies that are being undertaken that require the participation of patients. The involvement of patients in studies is necessary for the development of new treatments and can also have a positive impact on the clinical outcomes of those patients that participate in the trials. In 2015 there were over 1,000 active research projects that the OUH was involved in.

By working with the University of Oxford, the patients of the OUH are able to benefit from new treatments and therapies that are trailed in the OUH prior to a more general roll out.

13.2 Returns to Medical Research

Much of the economic contributions of medical research are qualitative in nature, however there have been some attempts to quantify its impact. Research by the Wellcome Trust on the value of medical research in the UK considers two types of return: health gains (net of the health care costs of delivering them) and economic gains[63]. This section considers the value of both.

13.2.1 Quality of Life Impact

The value of health gains was assessed in the Wellcome Trust report using the quality adjusted life years (QALY) method[64]. This is a widely used method developed by health economists to assess how many extra months or years of life of a reasonable quality a person might gain as a result of treatment. The Wellcome Trust report considered two areas of medical research expenditure, for cardiovascular disease and mental health.

The value of the health benefit was presented as a return on the initial expenditure on the research (IRR). This varies slightly between the two different areas of study, and more widely between the different scenarios for each of the study areas. The best estimate for the IRR in cardiovascular disease research is 9.2%, although the report also considered high and low expenditure scenarios that ranged from 7.7% and 13.9%. Similarly, the best estimate for the IRR for investment in mental health research was 7.0%. The high and low estimates for this area of study had a greater range and varied between 3.7% and 10.8%.

In order to apply these IRRs to the wide range of medical research undertaken at the University of Oxford the average of the two best estimates was used. Therefore for every £1 invested in medical research results in health gains with a value of £0.08 each year in the UK for perpetuity.

[63] Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK, For the Medical Research Council, the Wellcome Trust and the Academy of Medical Sciences, November 2008
[64] Ibid.

Table 13.2 – Quality of Life Impact Assumptions

	Assumption	Source
Medical Research Income	£340 million	University of Oxford (2014/15)
IRR	8%	Wellcome Trust
Discount rate	3.5%	BiGGAR Economics
Years covered	20	

Figure 13.2 – REF Case Study: The Oxford Knee[65]

The Oxford Knee was originally developed almost 40 years ago, and is a procedure that replaces only part of a knee, rather a total knee replacement, usually as a result of osteoarthritis. Since then, the Oxford Knee has undergone several iterations, with the Phase 3 iteration completed in 1998 with improved implant design, instrumentation, surgical technique and instruction.

The benefit of the Oxford Knee is that it is far less invasive procedure than a total knee replacement. As a result, recovery times are three times faster, the rate of infection and blood clots is half, and patients have higher mobility and a better range of movement. A recent study[66] found that for every 100 patients who underwent Oxford Knee surgery compared to total knee replacement, one fewer death occurred due to complications and there were three fewer re-operations, saving money and improving quality of life. To date over 1 million patients have received an Oxford Knee.

As in the Wellcome Trust report, the Net Present Value of the University's investment in medical research was calculated using the Treasury approved discount rate of 3.5%. Therefore, the total impact in the UK over 20 years was estimated to be £386.6 million. The impact in each of the other study areas was assumed to be proportional to their population.

Table 13.3 – Medical Research Impacts on Quality of Life (2014-15)

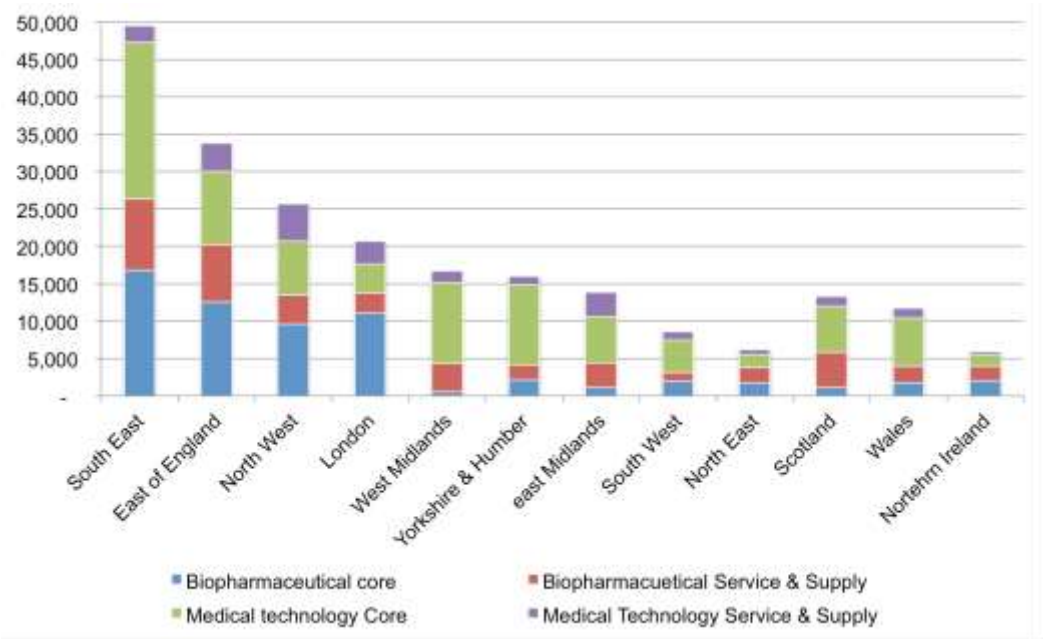
	City of Oxford	Oxfordshire	UK
GVA (£m)	1.0	4.1	386.6

13.2.2 Economic Impact

The University of Oxford is the largest medical research institution at the centre of the largest life sciences cluster in the UK. The life sciences sector in the UK had an annual turnover of £60.7 billion in 2015 and employed almost 222,000 people[67]. The South East of England, including Oxfordshire, has the highest concentration of this activity and in 2015 this sector employed almost 50,000 people in the South East of England. This is equivalent to 26% of the total employment in the UK. The core biopharmaceutical and medical technology sub sectors were particularly concentrated in the South East of England, with accounted for 29% and 28% respectively.

[65] REF (2014), The Oxford Knee: Revolutionising Knee Replacements
[66] Partial knee replacements for arthritis are safer than total replacement (2014). http://www.ox.ac.uk/news/2014-07-08-partial-knee-replacements-arthritis-are-safer-total-replacement
[67] HM Government (2015) *Strength and Opportunity 2015: The landscape of the medical technology and biopharmaceutical sectors in the UK*

Figure 13.3 – Geographic Split of Employment in UK Life Sciences by Sub-Sector



Source: HM Government, Strength and Opportunity 2015

There is a direct relationship between the high concentration of life sciences companies in the South east of England and the presence of the world's best medical research activity at the University of Oxford. The companies located in this area can benefit from the University's pool of over 6,500 life science specialist scientists and the companies can also take advantage of the local talent pool from the students that pass through the University[68].

The Wellcome Trust also considered the effect that medical research expenditure would have on GDP. The study considered the impact that this would have in stimulating investment in the private R&D sector and the social returns to the private investment that is stimulated by the publically funded medical research. This found that a £1 investment by a public body in medical research and development stimulated an increase in private R&D investment of between £2.20 and £5.10. The report also found that the social rate of return to private sector R&D funding was approximately 50%.

As with the estimates for the Quality of Life IRR, the study finds that there is a range of estimates for the IRR for GDP impacts. The lowest estimate for IRR is 20% and the highest is 67%. The best estimate that is given is 30%. Unlike the Quality of Life research, there was no estimates given for the GDP impacts associated with mental health research and therefore the 30% is assumed to apply to all types of medical research. Therefore, for every £1 invested in medical research results in GDP with a value of £0.30 each year in the UK in perpetuity.

[68] OBN (2011) OBN BioCluster Report 2011: Transition

Table 13.4 – Economic Impact Assumptions

	Assumption	Source
Medical Research Income	£340 million	University of Oxford (2014/15)
IRR	30%	Wellcome Trust
Discount rate	3.5%	BiGGAR Economics
Years covered	20	

As in the Wellcome Trust report the Net Present Value of the University's investment in medical research was calculated using the Treasury approved discount rate of 3.5%. Therefore, the total impact in the UK over 20 years was estimated to be £1.4 billion. The impact in each of the other study areas was assumed to be proportional to their population. However, this is likely to underestimate the impact around the Oxford City and Shire as stimulated private R&D expenditure is likely to occur in clusters near the original spend, as shown by the high concentration of life sciences employment.

Table 13.5 – Economic Returns to Medical Research: 2014-15

	City of Oxford	Oxfordshire	UK
GVA (£m)	3.7	15.5	1,449.7

13.2.3 Total Returns to Medical Research

The total return to medical research is found by summing the economic and social contributions. This found that the economic contribution is £1.8 billion in the UK. These are the long-term impacts associated with research undertaken in 2014/15.

Table 13.6 – Returns to Medical Research: 2014/15

	Oxford City	Oxfordshire	UK
Social Returns	1.0	4.1	386.6
Economic Returns	3.7	15.5	1,449.7
Total Returns	**4.6**	**19.7**	**1,836.2**