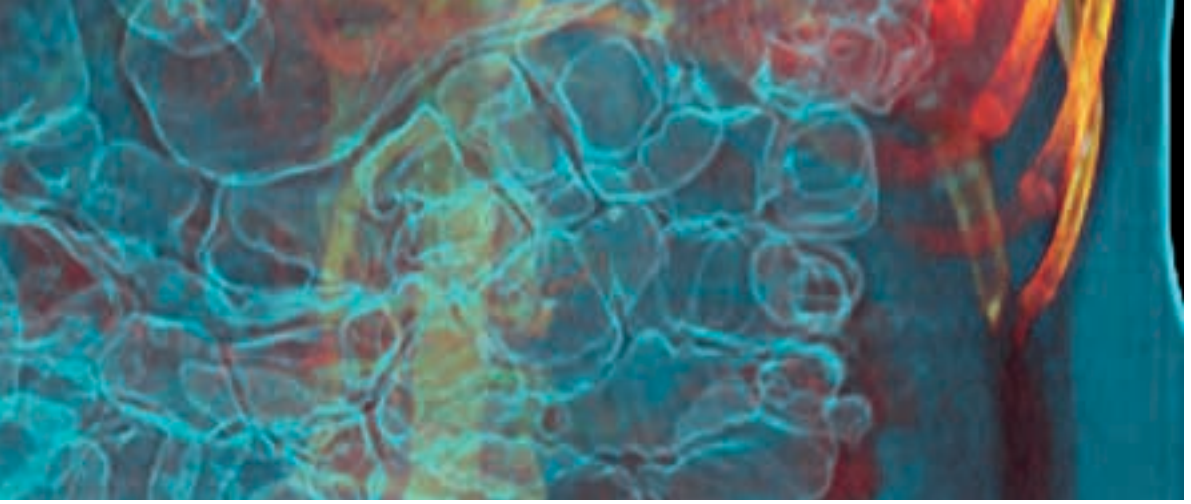
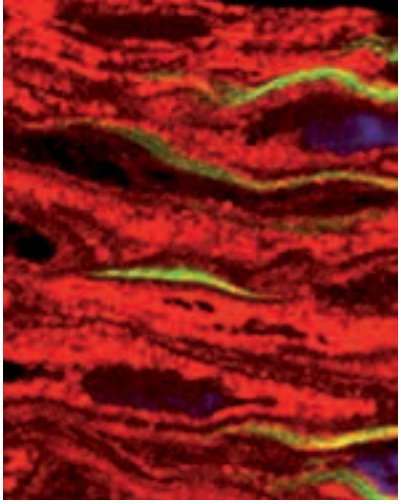
MRC Medical Research Council

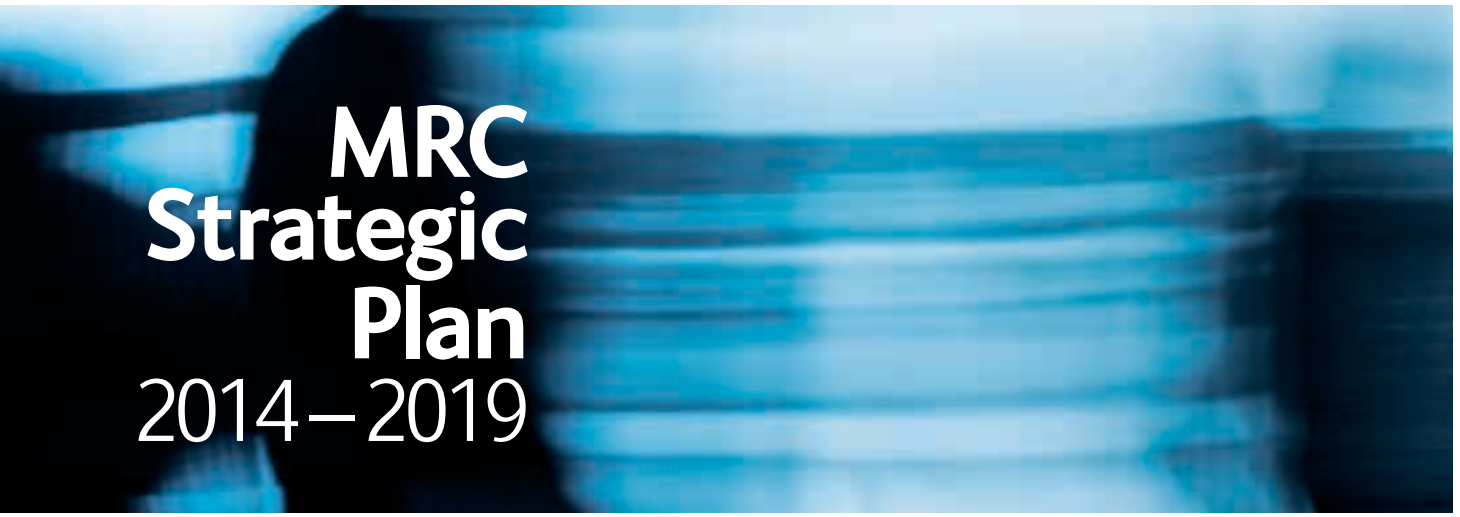
Research CHANGES Lives 2014–2019

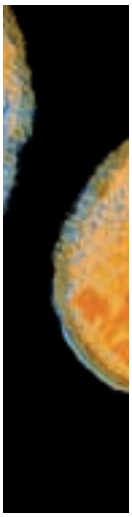
MRC STRATEGIC PLAN

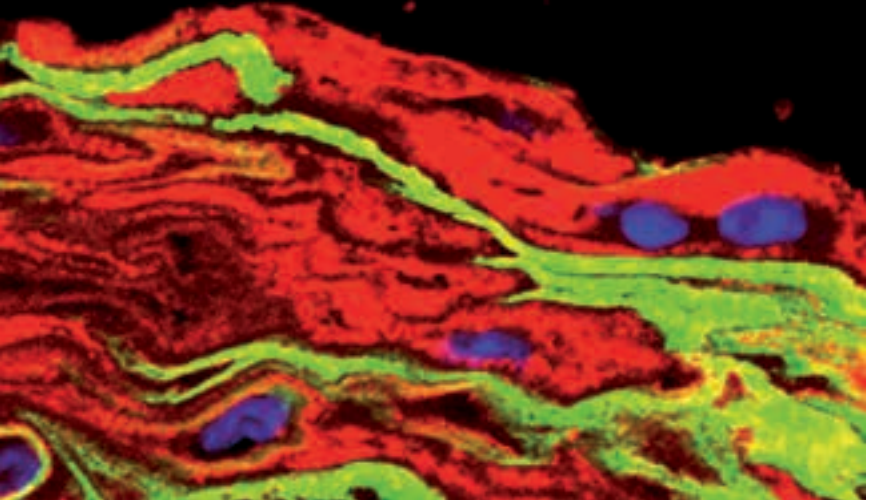


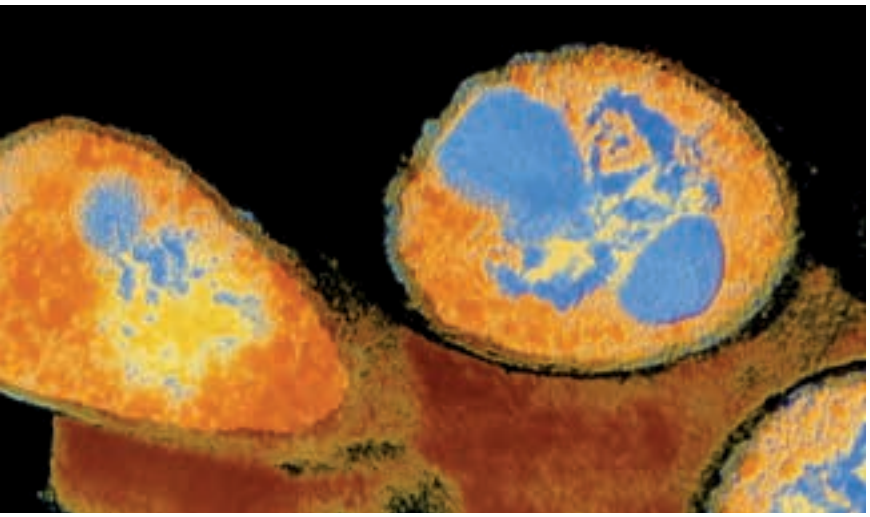


MRC Strategic Plan 2014–2019









Foreword

The MRC celebrated its centenary in 2013, presenting the chance to reflect on the ground-breaking discoveries made by MRC scientists over the last hundred years that have transformed knowledge and saved many lives. They include the discovery of the flu virus and the structure of DNA, which encodes our genes, setting the gold standard for clinical trials to test new medicines, demonstrating that high blood pressure causes heart disease and strokes, and that cholesterol-lowering drugs reduce the risk of these diseases.

In the future, we will continue to build on our strengths in scientific excellence to **improve the health and wellbeing** of society and to **boost innovation and economic growth**. Our strong commitment to supporting high quality **fundamental discovery research** will remain at the heart of our strategy. These discoveries often have the potential for the greatest impact in the longer term. An example is the discovery of monoclonal antibodies in the 1970. These now form a third of all new drugs in development for a wide range of diseases such as cancer, arthritis and multiple sclerosis that are expected to reach a global market of $60bn by the end of our centenary.

Partnerships are essential to bring the benefits of our research to people. During *Research Changes Lives 2009–2014*, the MRC's strategic plan which has guided our work for the last five years, we have enhanced interactions with industry, the National Institute for Health Research (NIHR) and health departments in the devolved administrations, the Department for International Development, medical research charities, universities, research councils, and the international community. We will now build on and expand these relationships to secure the impact of our research for the future.

Recent years have seen dramatic changes in the way MRC engages with industry. This includes the establishment of the £180m Biomedical Catalyst in partnership with the Technology Strategy Board to speed up the development of new interventions, and the initiation of completely new ways of working with companies: the development of disease-specific consortia to investigate why patients respond differently to drugs and a joint initiative with AstraZeneca making available clinical compounds to better understand diseases. In the future we will further strengthen our **partnerships with the Technology Strategy Board and industry** to promote the development of new treatments, diagnostics and preventative strategies, and to encourage inward investment that drives sustainable growth, creates

jobs, and maintains the UK's leadership in biomedical research. We will further expand the concept of bringing together the best clinical scientists with patient networks and industry partners to better define diseases and develop more tailored treatments and will widen our range of partnerships with industry.

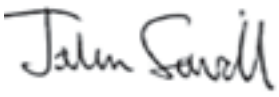
Of equal importance is our **strong relationship with the NIHR and UK health departments**. Jointly with the NIHR and other funders we have invested £150m to support medical bio-informatics research putting in place the infrastructure and developing the skills to benefit from the enormous amount of research and safely guarded NHS patient data that is now becoming available. We have also invested in high throughput technologies such as sequencing hubs across the UK and the MRC-NIHR National Phenome Centre, which analyses chemical processes in the body. We will build on and further **expand our investment in medical bioinformatics and analytical tools** so that our scientists can capitalise on the data revolution to understand how our genes and environmental factors influence health, and to discover risk factors, drug targets and diagnostic tools to speed up disease treatment and prevention. An important goal will be to **learn more about the fundamental biology in health and disease in humans**, and to translate these discoveries into benefits for human health through effective partnerships, including with industry. To achieve this goal our researchers will work closely with the NIHR Biomedical Research Centres and Units in England and their counterparts in Northern Ireland, Scotland and Wales.

Many of our investments involve charitable organisations and we will continue to **strengthen our partnerships with medical research charities** to ensure that patient voices are heard. We will build on and enhance existing relationships for instance with the Wellcome Trust, Cancer Research UK, Arthritis Research UK, Asthma UK, and the British Heart Foundation, and will forge new alliances. An example of these collaborations is the establishment of the Francis Crick Institute, a major new UK medical research institute, jointly with Cancer Research UK, the Wellcome Trust and three London Universities. Equally, we will continue to **work with international partners** and combine resources and skills to tackle global challenges to health.

Research across the boundaries of scientific disciplines has led to the development of new technologies that have revolutionised health care. Magnetic Resonance Imaging (MRI) for example, based on MRC funded science in the 1970s has increased the success of spinal cord surgery and cancer therapy and associated industries are estimated to add £600m to UK GDP between 2011-2015. Over the last five years we have fully integrated more than half of our MRC Units within Universities and have made new investments that will promote new discoveries and technological innovation such as hubs for next generation microscopy. We will further **re-shape the UK medical research ecosystem** and **strengthen partnerships with and across universities and with research councils**. This will encourage **the interdisciplinarity** needed to tackle the big questions in medical research for instance driving forward our ambitions in regenerative medicine and vaccine research. The 'proximity to discovery' will provide opportunities for investment by the private sector and stimulate economic growth.

In the future, we will continue to support high quality discovery science across the MRC's portfolio combined with targeted funding to tackle the challenges of the 21st century. These include the development of new drugs to fight antimicrobial resistance and better strategies to combat devastating diseases such as dementia.

Mr Donald Brydon
Chairman



Professor Sir John Savill
Chief Executive

Research CHANGES Lives 2014–2019

A refreshed Strategic Plan for the MRC from 2014–2019

In 2009 the MRC published its Strategic Plan *Research Changes Lives 2009–2014* to describe the strategy for delivering the MRC's mission. *Research Changes Lives 2009–2014* defined the MRC's distinctive role in contributing to faster and more effective ways for medical research to flourish, at all stages – from working to understand the fundamental science prior to having specific health questions in mind, to tackling some of the most pressing health issues facing society.

MRC Council and Strategy Board agreed that the overall direction outlined within the four high level aims in *Research Changes Lives 2009–2014* remained of major importance for the future and that the objectives to achieve these aims should be refreshed in the light of new scientific opportunities and potential for impact. They led a comprehensive review programme to develop *Research Changes Lives 2014–2019*, which sets out MRC's strategic vision for the next six years. This sought a wide range of views for example from MRC research boards, overview groups, panels, directors and fellows, the Pharma Forum, and scientific workshops, Research Councils, the Academy of Medical Sciences, and Association of Medical Research Charities.

Research Changes Lives 2014–2019 continues MRC's strategic direction, building on strengths and achievements and further developing our aspirations and commitments with the view of securing tangible impacts from our research. The refreshed Strategic Plan aims to provide clarity on MRC's priorities and the stability of our strategic direction. It will provide the framework for spending review bids to Government, facilitate active partnerships with universities, institutes and units, provide pathways for engagement for example with medical research charities, industry, the Technology Strategy Board, NIHR/health departments, and the Research Councils, and communicate our vision for addressing health and wealth to the public.

The investments and achievements made during R*esearch Changes Lives 2009–2014* have been published in a Mid-term Progress Report[1]. *Research Changes Lives 2014–2019* continues to set the path for health and wellbeing through developing prevention interventions, new treatments for diseases, well-founded policy guidance for research governance and ethics, and maintaining excellence in the fundamental research that underpins these activities. It strives to secure measurable impacts that improve public health and UK wealth.

MISSION

Established by Royal Charter in 1913, the MRC's mission in the 21st century remains pivotal in setting the strategic direction and requires the MRC to:

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

1 Research Changes Lives: Mid-term update on progress http://www.rclprogress.mrc.ac.uk/

Strategic intent

Over the next six years the MRC aims to support excellent discovery science across the spectrum of biomedical research and strengthen partnerships to accelerate the pace of improvements in health and wealth.

We will achieve this through:

STRATEGIC AIM ONE

Picking research that delivers: Setting research priorities which are most likely to deliver improved health outcomes.

STRATEGIC AIM TWO

Research to people: Bringing the benefits of excellent research to all sections of society.

STRATEGIC AIM THREE

Going global: Accelerating progress in international health research.

STRATEGIC AIM FOUR

Supporting scientists: Sustaining a robust and flourishing environment for world-class medical research.

These strategic aims, set out in more detail in the following sections, explain how the strategy will drive progress in support of the MRC's mission, and deliver measurable impact of the outcomes of research. Each aim follows a hierarchical structure, with objectives to outline the goal, information about the current situation, the aspirations for the future and an explanation of how we will reach this goal.

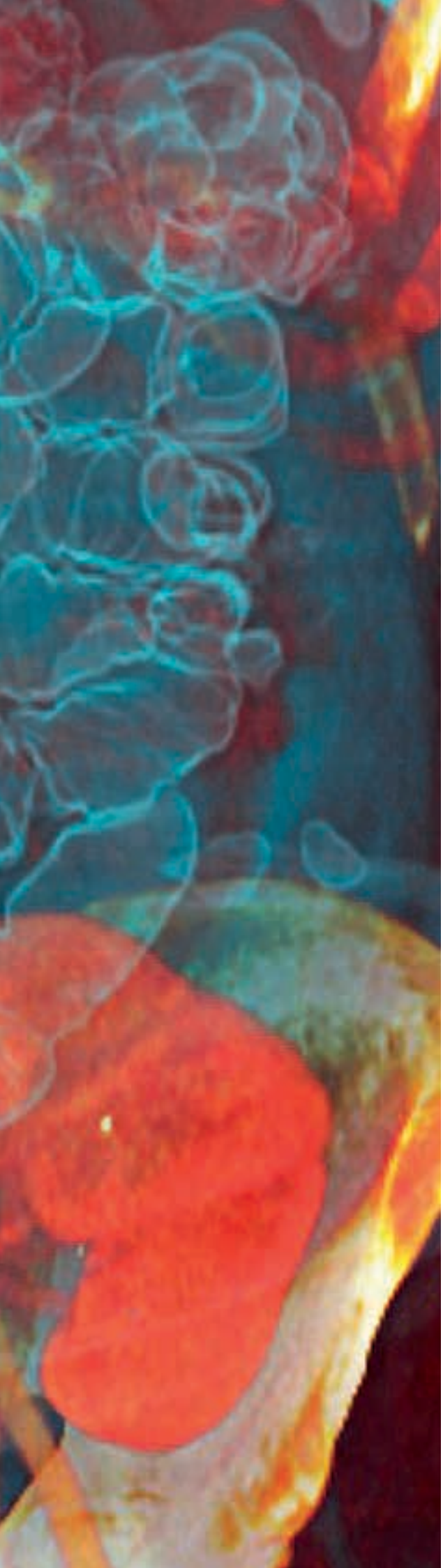
Our strategy is to support excellent research in areas that are poised to deliver substantive progress in tackling health challenges facing the UK and the world. While aiming for maximum impact, we also support excellent science in areas that would be otherwise neglected or under-funded. To achieve this, the MRC supports research across the biomedical spectrum, from basic science to clinical studies. The MRC will continue to fund high-quality research through response-mode grants.

IMAGE: Advanced MRI scan of a human brain
Magnetic resonance imaging (MRI) can reveal microscopic details of tissues *in vivo*. This image was produced using ultra high-field MRI to show the many neural pathways that exist in a normal human brain. MRI was first developed by Peter Mansfield in 1973, while funded by the MRC. The discovery of MRI and its transformation of medicine was recognised by the award of the Nobel Prize in 2003. Today more powerful MRI machines and new ways to contrast living tissue are providing unprecedented views inside the human body and the approach is fundamental in many conditions for diagnosis and preparation for treatment. In 2009/10, two million MRI examinations were performed by the NHS.

STRATEGIC AIM ONE

Picking research that delivers

SETTING RESEARCH PRIORITIES WHICH ARE MOST LIKELY TO DELIVER IMPROVED HEALTH OUTCOMES



The MRC will speed up the exploitation of the best ideas in medical science, from fundamental discovery science to innovative preventative and therapeutic interventions in humans. We will fund science of the highest quality across the breadth of disciplines relevant to improving human health.

RESEARCH PRIORITY THEME ONE:
Resilience, repair and replacement

RESEARCH PRIORITY THEME TWO:
Living a long and healthy life

IMAGE: Transplanted kidney, CT scan
Coloured 3-D computed tomography (CT) scan of the chest and abdomen of a kidney transplant patient. Transplantation replaces a failed or failing kidney with a donor kidney which must be grafted on to a different blood supply since the diseased kidney is not removed. The demand for donor kidneys is far higher than the number available. In 2010/11 in the UK there were almost 3,000 kidney transplants, but this still left just under 7,000 people on the waiting list for a healthy kidney. The MRC Centre for Transplantation at Kings College London is at the forefront of research that is extending the ability to store donor organs in a healthy state, and reduce the rejection of donated organs. This includes the development of Mirococept, a drug designed to extend the life of transplanted kidneys, currently being evaluated in a clinical trial.

RESEARCH PRIORITY THEME ONE

Resilience, repair and replacement

Discovery science has opened up new opportunities for interventions in many diseases such as cancer, dementia, heart disease and restricted mobility through bone and joint disease. Understanding more about the mechanisms of resilience, repair and replacement will help channel discoveries towards preventing and treating disease.

OBJECTIVES

NATURAL PROTECTION:

To understand how resilience to disease and degeneration develops and breaks down, how it may be exploited for new interventions that improve disease processes, and how to repair it when it goes wrong.

TISSUE DISEASE AND DEGENERATION:

To advance knowledge in the biology of ageing and degeneration of human tissue and to progress research tackling dementia; to understand the mechanisms of chronic inflammation and how these relate to disease.

MENTAL HEALTH AND WELLBEING:

To explore the risk factors for poor mental health, and the relationship between mental and physical health, wellbeing and resilience to disease processes.

REPAIR AND REPLACEMENT:

To translate the burgeoning knowledge in regenerative medicine into new treatment strategies.

Natural protection

The human immune system protects the body throughout life, providing resilience to disease and degeneration. Understanding this immunity, how it breaks down with age or disease and how it responds to pathogens is critical to developing ways to prevent and treat infections, autoimmune diseases and allergy, and to improve strategies for transplantation.

OBJECTIVE

To understand how resilience to disease and degeneration develops and breaks down, how it may be exploited for new interventions that improve disease processes, and how to repair it when it goes wrong.

NOW

- We support strong fundamental and translational research in immunology via, for example, the National Institute for Medical Research (which will transfer to the Francis Crick Institute) and the MRC Human Immunology Unit in Oxford.
- We fund research into the basic understanding of pathogens for example through the MRC-University of Glasgow Centre for Virus Research and the MRC Centre for Molecular Bacteriology and Infection at Imperial College London.
- We have developed interdisciplinary consortia in immune and infectious disease research – which have provided a model for future joint working across institutions and public/private sectors.
- We support internationally respected global health research into infectious diseases and have boosted our investment in neglected tropical diseases.
- We are developing a systems biology approach to understanding the immune system in both health and disease, and how it changes over the life course.

FUTURE

We aim to deepen our understanding of the human immune system from early life through to old age using a combination of experimental medicine and modern approaches in systems and computational biology. We wish to accelerate the development of new immunotherapies – disease treatments which use the immune system – and treatments for immune diseases.

- We aim to tackle the mechanisms of bacterial resistance to antimicrobial treatments and strengthen innovation in **antimicrobial development** through academic-industry partnerships.
- We aim to exploit new technologies and create new ways of developing **vaccines** to prevent both infectious and non-communicable diseases.
- Recognising the importance of the **'One Health' agenda**, which highlights the links between animal and human diseases, and the opportunities of synthetic biology we wish to encourage interactions with the Biotechnology and Biological Sciences Research Council to achieve our ambitions in creating novel antimicrobials and vaccines.
- We aim to understand the inherited, general (innate) immune response and the specific (adaptive) immune response acquired throughout life – and how these respond when faced with pathogens **(the host-pathogen interface)**.
- We seek to determine the **role of diet** in how the immune system develops and functions over the life course, as well as the role played by the **microbiome**.
- We aim to use **stratified medicine** approaches to categorise **people's responses to infectious diseases** and determine why some people suffer more severe effects than others.
- Working in partnership with the NIHR we wish to increase our ability to **respond to new and re-emerging infections**.

HOW

We will support discovery research and foster the interdisciplinary research environments required to tackle our resilience and response to diseases.

- The Francis Crick Institute will provide such an environment, particularly for the investigation of fundamental immunology, and how humans and pathogens interact.
- We will support centres of excellence and consortia that link the best academic science with clinical research and infrastructure and engage with industry and other partners to deliver innovation in areas of need such as vaccinology and antimicrobial resistance.
- To maximise our investments, we will link existing centres of excellence to embark jointly on new research topics, for example, combining our strengths in immunology with those in nutrition research.
- We will encourage robust studies investigating the link between changes in the microbiome and health.

MAKING AN IMPACT: THE MECHANISM OF SEVERE ACUTE INFLUENZA CONSORTIUM (MOSAIC)

This multi-centre study of patients hospitalised with severe influenza is funded by the MRC and the Wellcome Trust. MOSAIC brings together clinicians, geneticists and experts in disease modelling from across academic, charitable and public sector research organisations with the aim of progressing discovery research in the causes of severe influenza. The study has identified a gene called IFITM3, variants of which could help explain why influenza becomes a life-threating disease to some people and has only mild effects in others[2]. MOSAIC was the first such large-scale cooperative for pandemic influenza and has been used as the template for a far larger global consortium, the International Severe Acute Respiratory Infection Consortium (ISARIC), which tackles outbreaks of respiratory disease that have pandemic potential.

2 IFITM3 restricts the morbidity and mortality associated with influenza Nature 484, 519–523 (2012) doi:10.1038/nature10921

Tissue disease and degeneration

Life expectancy is increasing and more people are living to ages at which they experience common chronic and degenerative diseases. Most people aged 60–64 have at least one medical condition requiring regular GP visits[3]. One in three people is expected to develop dementia, which will have major consequences for patients, their families and society as a whole. Chronic inflammation is linked to many age-related diseases such as heart failure and arthritis. Learning more about the fundamental mechanisms of chronic disease will help to identify new targets for therapies, open up opportunities to use existing drugs for different diseases, and develop tailored and more effective treatments.

OBJECTIVE

To advance knowledge in the biology of ageing and degeneration of human tissue and to progress research tackling dementia; to understand the mechanisms of chronic inflammation and how these relate to disease.

MAKING AN IMPACT: DISCOVERY OF ALZHEIMER'S DISEASE GENE OPENS UP NEW POSSIBILITIES FOR DEMENTIA PREVENTION

The most potent genetic risk factor for Alzheimer's disease identified in the past 20 years was discovered in 2012 by an international team including researchers funded by the MRC. The gene nearly triples the risk of a person developing Alzheimer's disease[4].

The gene was discovered using a new genetic sequencing technique called exome sequencing[5] and could be used to identify people at high risk of Alzheimer's disease who would be suitable for prevention trials. TREM2 is known to be involved in the immune system which may identify new leads in understanding the causes and progression of Alzheimer's disease.

NOW

- We have established imaging capacity to support research into degenerative diseases of ageing, including Imanova Ltd, a partnership with London universities which specialises in Positron Emission Tomography (PET) imaging, a type of medical imaging which produces detailed 3D images of how well a body system is functioning.
- We fund centres of excellence tackling inflammation, the allergic basis of asthma, and the ageing of muscles of tissues, in partnership with medical research charities.
- We support a range of tissue resources, including the UK Brain Banks Network which provides access to post-mortem brain tissue for research into neurodegenerative and other brain diseases.
- We have established effective international networks that help us to address bottlenecks in neurodegenerative disease research.

FUTURE

- Using genetics and **high-throughput 'omics' technologies** we aim to improve knowledge of the **molecular pathways** that cause degenerative diseases such as atherosclerosis, heart disease, chronic obstructive pulmonary disease, osteoarthritis, neurodegenerative diseases, and dementia.
- We seek to establish new ways of **detecting degenerative diseases before symptoms develop** and to better understand how susceptibility to, and progression of, disease varies between people based on molecular pathways, so that interventions can have greater impact.
- We aim to explore the **links between how cells age, chronic inflammation and the damage this causes to tissue**.
- We aim to understand why some neural networks are more sensitive to degeneration than others and what age-related changes in such networks cause these diseases to happen only in later life.
- We seek to provide **better models of disease** for pre-clinical research and to establish **experimental medicine platforms** so that new therapies can be progressed to patients.
- We aim to exploit the MRC's strength in population-health research to promote discovery research and strategies for disease prevention. Important goals are to understand the **brain body axis** and how **co-morbidities** – having other diseases at the same time – affect the severity of disease.

3 Pierce, M.B. et al. (2012) *Clinical disorders in a post war British cohort reaching retirement: evidence from the First National Birth Cohort Study*. PLoS ONE, 7 (9). e44857. ISSN 1932-6203 (doi:10.1371/journal.pone.0044857)

4 TREM2 Variants in Alzheimer's Disease. *New England Journal of Medicine*, 2012; 121114171407007 DOI: 10.1056/NEJMoa1211851

5 Exome sequencing uses just coding regions of the genome (about 1% of the human genome) and so is more efficient and quicker at discovering rarer variants than whole genome sequencing. It was first demonstrated as a viable approach for hunting gene variants responsible for disease in 2009.

HOW

- We will support discovery science in cells and tissues, and target funding towards understanding the causes and fundamental mechanisms of diseases linked to chronic inflammation and degeneration.
- We will increase capacity in neurodegeneration research by encouraging links with biomedical researchers from other fields, and fostering international collaborations to supplement UK strengths.
- We will progress national platforms, which can provide imaging, high-throughput 'omics' and health informatics data, and biological samples, linked to population cohorts to undertake 'deep phenotyping'. A major such investment will be the establishment of a UK platform for dementias research.
- We will build relationships with NIHR and health departments, medical research charities, and the biopharmaceutical industry to progress our shared agenda in mechanistic and translational research.
- We will promote the use of stem cell-based approaches and tissue-equivalent assays to model diseases and test drugs.
- We will exploit our recent £20m investment in next generation optical microscopy to analyse cell function in tissues at risk of scarring or degeneration.

Mental health and wellbeing

At any one time, one in six people in the UK are experiencing a mental illness such as depression. This costs the economy in England alone an estimated £105 billion a year. In 2010 the MRC published an influential review of mental health research[6], which concluded that the UK has the potential to build capacity and bring innovation to research into mental health conditions. Applying new approaches to research, identifying early risk factors and exploring resilience will drive progress in preventing mental illness and developing new treatments.

OBJECTIVE

To explore the risk factors for poor mental health, and the relationship between mental and physical health, wellbeing and resilience to disease processes.

NOW

- We support a broad range of fundamental research in neurosciences within, for example, the MRC Laboratory for Molecular Biology, the developing Francis Crick Institute and at many MRC units and centres.
- We support pioneering research to understand cognitive processes such as attention, learning, and memory, which are affected in many mental health and neurodegenerative diseases.
- We fund innovative exploratory experimental medicine studies for new treatments in mental health.
- We support projects that link population data and patient data to study the causes of mental illness, and continue to support major epidemiological and genomic studies identifying the risk factors for poor mental health.
- Together with the Medical Research Foundation, the MRC has established a new clinical research training programme in psychiatry.

FUTURE

- We seek to strengthen our knowledge of **cellular and molecular neurological mechanisms** and the function of the brain and how this relates to mental health and disease.
- We aim to understand the connections between the brain and other body systems, and understand the genetic and environmental **risk factors** that cause mental illness.
- We will explore the potential for **neuroinformatics**, to understand brain function by analysing, integrating and modelling experimental and clinical data.
- Through investment in **experimental medicine** we will inform new therapeutic approaches and exploit existing and new data to inform preventive strategies.
- Rapidly emerging knowledge about the **role of the genome in mental illness and advances in developmental biology** will help us to unravel the complexity of emotional and behavioral disturbances and inform proof of concept in potential new therapies.
- We aim to **harness the richness of data** from cohort studies and health-related records and new technology to accelerate the development of **preventive strategies** against mental illness across the life course.

MAKING AN IMPACT: MINDFULNESS-BASED COGNITIVE THERAPY – A PROMISING NEW APPROACH TO PREVENTING DEPRESSIVE RELAPSE

Mindfulness-based cognitive therapy (MBCT) was developed as a way of teaching people with a history of depression the skills to stay well in the long term. MRC-funded researchers at Exeter University have translated early ideas about MBCT into a technique which, when combined with antidepressants, has been shown to reduce depression more than antidepressants alone in early phase studies. NICE now recommends MBCT for relapse prevention and the NIHR has funded a major late-stage trial of MBCT which is due to finish in 2013.

HOW

We will support discovery research across the breadth of neuroscience and mental health, with an emphasis on linking genome data and cognitive processes with behavior and neuronal systems.

- We will advocate an approach that works across clinical criteria and focuses on the role of complex networks shared by different disorders.
- We will make full use of data from cohort studies and health-related records and continue to determine how mental illness emerges during periods of vulnerability in development.
- We will initiate focussed exemplar areas in partnerships with industry such as understanding interactions between mental illness, inflammation and metabolic processes. We will also exploit UK expertise in complementary areas such as computational and developmental biology.
- We will form partnerships with other stakeholders, especially industry and mental health charities, to encourage exploration of new experimental approaches combined with new methods such as stratification and adaptive design of clinical trials.
- We will explore how a person's social circumstances and life history contribute to their mental health and how this knowledge combined with genetic risk, assessment of personality, cognition, behaviour, and brain function can be used in treatment strategies.

6 http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC006848

Repair and replacement

Regenerative medicine has the potential to provide treatments for patients with debilitating and incurable conditions by providing cells or tissues for transplantation or by stimulating self-repair. Diseases that may be targeted include chronic health problems associated with ageing such as bone or joint repair, age-related blindness and cardiovascular problems. The UK has the potential to build a world-leading regenerative medicine industry that will benefit UK health and wealth.

OBJECTIVE

To translate the burgeoning knowledge in regenerative medicine into new treatment strategies.

MAKING AN IMPACT: WORLD FIRST CLINICAL TRIAL OF STEM CELL-ENGINEERED LARYNX (VOICE BOX)

In 2008 MRC-funded researchers at University College London carried out the first transplant of a human trachea (wind pipe) reconstructed using stem cells. By 2013 the group were ready to build on this success by developing the first clinical trials of a stem cell-derived larynx transplant in a project known as "RegenVOX". The RegenVOX procedure involves preparing a reconstructed larynx made from the patient's own stem cells and a donor larynx. The team uses chemicals to remove the cells from the donor larynx, leaving behind a scaffold onto which the patient's stem cells are grafted. This means that the new larynx will not be rejected by the immune system so patients do not need immunosuppressant medication. The team is also able to turn the patient's stem cells into cartilage-producing cells to give natural strength to the transplant, and into replacement mucous membrane cells to line the inside, just like a normal larynx.

NOW

- We support centres of excellence in regenerative medicine in Edinburgh and jointly with the Wellcome Trust in Cambridge.
- We are supporting early-phase clinical trials of adult stem cell therapies for a variety of diseases.
- MRC-funded researchers are conducting the second ever trial using human embryonic stem cells lines to treat an age-related form of blindness called macular degeneration. Pfizer is investing in this trial, which is an important endorsement of the quality of UK research.
- The UK Stem Cell Bank makes quality-controlled and ethically-sourced human embryonic stem cell lines available to researchers and stores the world's first clinical grade human embryonic stem cell line.
- Through the UK Regenerative Medicine Platform, a cross-council initiative, we are supporting research hubs in key areas necessary to drive forward stem cell therapies: safety and efficacy; 'acellular' approaches using biomaterials and drug delivery; engineering and exploiting the microenvironment of stem cells (the stem cell 'niche'); and scaling up the production of cells.

FUTURE

- We aim to harness the potential of stem cell biology and cell 'reprogramming' technologies to provide renewable supplies of **defined cell and tissue products** for transplantation.
- We aim to promote **self-repair** by stimulating the body's own regenerative processes.
- We aim to establish **proof of concept in regenerative medicine therapies** in a number of disease areas.
- We aim to progress **clinical trials of therapies that also feed discoveries back** to the laboratory to better understand stem cell biology and improve the design of future studies.
- We aim to establish **supportive technologies** to help target the delivery of regenerative medicine therapies within the body and improve efficacy and safety.

HOW

The MRC will lead a coherent regenerative medicine programme in partnership with other research councils, the Technology Strategy Board, the NIHR and UK health departments, medical research charities and industry to ensure the UK maintains its leading global position.

- We will continue to invest in discovery research in stem cell biology.
- We will support approaches involving embryonic stem cells, induced pluripotent stem cells and adult stem cells, as well as research into biomaterials and gene therapy technologies to advance strategies for repair and replacement.
- We will accelerate progress in regenerative medicine by bringing mathematical, physical and engineering sciences into the field.
- We will target funding towards translational projects that require an interdisciplinary approach and a critical mass of researchers to get therapies to the point of clinical testing.

Repair and replacement (continued)

- We will connect the best academic science with clinical research and commercial development, for example by supporting MRC centres and the UK Regenerative Medicine Platform.
- We will ensure that strategic national investments in stem cell banking, cell characterisation and manufacture, including the Cell Therapy Catapult, are connected and complement each other.
- We will work with regulators to ensure that the requirements for clinical development are effectively communicated and to inform a regulatory framework that is fit-for-purpose for this emerging field.

MAKING AN IMPACT: VITROSAFE LTD.

Founded by MRC-funded scientists in 2008, Vitrosafe Ltd has developed an enclosed bioprocessing system for reproductive technologies in collaboration with Walker Safety Cabinets and the Centre For Life, Newcastle upon Tyne Hospitals NHS Trust. The Vitrosafe system is designed to meet good manufacturing practice (GMP) standards during the handling of embryos and stem cells in the laboratory, and has been shown to increase the survival of embryos. Vitrosafe Ltd. has successfully exported around £1m worth of systems to Canada, Europe and Thailand, and the founders have won a number of business and innovation awards.

RESEARCH PRIORITY THEME TWO

Living a long and healthy life

Health professionals, policy makers and individuals can potentially improve the chances of having a healthier life by addressing the complex interactions between genetics, development, and life events and lifestyles. In the fields of genetics and genomics, population sciences and in tailoring interventions to individual needs, there are opportunities for research aimed at determining how these factors influence the quality and length of life.

OBJECTIVES

MOLECULAR DATASETS AND DISEASE:

To use genetics, imaging and biological indicators to understand predispositions to disease, and target treatments to disease subtypes.

LIFE COURSE PERSPECTIVE:

To drive forward interdisciplinary population-based research into health and wellbeing from childhood to older age.

LIFESTYLES AFFECTING HEALTH:

To inform the development of effective strategies for promoting healthy behaviour and tackling lifestyles that lead to disease.

ENVIRONMENT AND HEALTH:

To explore the impact of our environment on health and wellbeing.

Molecular datasets and disease

We are using human population-based research and targeted genetic changes in animal models to increase our understanding of how a person's genetic makeup can predispose them to disease or affect how they will respond to treatment. The biomedical and health research sectors now operate in the 'big data' era where new opportunities exist to extract insights from large and complex datasets. Taking these opportunities will help us to understand the relationship between genetics and other factors in health and disease and determine important molecular pathways for the targeting of therapeutics.

OBJECTIVE

To use genetics, imaging and biological indicators to understand predispositions to disease, and target treatments to disease subtypes.

NOW

We are using rich cohort, tissue and animal model resources to reveal insights into the biological causes of disease, and how they interact with exposures to the physical and social environment.

- The MRC has invested in high-throughput 'omics' technologies (such as genomics, proteomics and metabolomics) and imaging approaches to enrich existing cohort and tissue resources.
- We are supporting the genotyping of all 500,000 participants in the UK Biobank cohort. The Department of Health's 100k Genome Project, which will sequence the genomes of 100,000 NHS patients in England will also provide a valuable resource for research to understand diseases.
- We have made significant investments in medical bioinformatics and health informatics to enhance the UK's capability to tackle the challenges of the big data era.
- Animal models including mouse, rat, fish and fly continue to reveal insights into human disease. Working with international partners we have invested in the phenotyping of mouse mutants to provide a resource for the scientific community.

FUTURE

We aim to better understand the complex connections between genomics and other biological factors, which may be influenced by people's environment and lifestyle, and use large collections of biological samples and computational methods to reveal new insights into the causes and mechanisms of disease.

- We aim to improve understanding of the role of genes and other biological factors in the predisposition to, and progression of, disease, and how this knowledge can be exploited for the prevention of diseases.
- We aim to better understand the interactions within and between complex biological systems so that we can understand the causal pathways of diseases and reveal those at which to target new treatments.

HOW

We will bring together new approaches for generating and analysing data on genetic and other biological indicators, and use new models to explore molecular pathways of diseases and new targets for therapeutics.

- We will expand the use of new **high-throughput technologies** to study human cohorts, collections of human tissue and animal models so that we can deliver insights into the relationship between exposures for example of a physical, chemical, or social nature, biological factors and disease.
- We will build on the UK's strengths in **epigenetics** to better understand what triggers epigenetic changes and how they influence disease.
- We will continue to invest in innovative **analytical infrastructure and medical bioinformatics** (including skills, methodologies and technologies) to improve the analysis and linking of large-scale genome and phenome information to patient and population data.
- We will invest in innovative **synthetic and chemical biology** to create new tools to understand mechanisms of disease and offer opportunities to develop new families of treatments and vaccines.
- We will invest in dynamic, quantitative computational modelling approaches and novel imaging technologies to improve our understanding of complex **biological systems** at the cellular, organ and whole-system levels.

MAKING AN IMPACT: UK ACADEMIC CONTRIBUTION TO NEXT-GENERATION SEQUENCING TECHNOLOGY

Chemical biology research at Oxford University funded by the MRC and the Engineering and Physical Sciences Research Council led to the establishment of the spin out company Oxford Nanopore Technologies (ONT). Based on its transformative nanopore sequencing technology ONT has successfully raised more than £100m in funding to pursue the development of products in this area. Other leading companies in DNA sequencing, Illumina and Life Technologies, also use UK academic discoveries funded by research councils. Illumina relies on 'Sequencing by synthesis' technology and Life Technologies, which was recently acquired by Thermo Fisher for nearly $14bn, relies on electrochemical detection of DNA.

Life course perspective

Life expectancy is increasing in the developed world by more than five hours a day. Health, wellbeing and lifespan are influenced by complex interactions between biological, environmental and socioeconomic factors throughout life. To fully realise the benefits of living longer it is essential that we understand the contribution of the factors that shape healthy ageing and susceptibility to disease across the age spectrum from birth to older age.

OBJECTIVE

To drive forward interdisciplinary population-based research into health and wellbeing from childhood to older age.

NOW

- The MRC has renewed its commitment to supporting the world's oldest birth cohort – the National Survey of Health and Development '1946 birth cohort' – and is investing in The Life Study, a new birth cohort recruiting a large number of mothers and babies.
- UK Biobank, a unique population cohort resource containing measurements of half a million adults aged between 40 and 69 at recruitment, is now being used by researchers.
- Initiatives such as the MRC Data Support Service and the MRC Population Cohort Strategy provide infrastructure and guidance to get the most out of our rich, long-term population data resources.
- Building on the jointly funded e-health informatics research centres, we have established the Farr Health Informatics Research Institute, a distributed UK institute that will link and interrogate research datasets and electronic patient records provided by initiatives such as the Clinical Practice Research Datalink in England and equivalent infrastructures in Scotland and Wales.
- Within the Lifelong Health and Wellbeing programme, the MRC is partnering with the Economic and Social Research Council, policy-makers and a broad range of UK employers to investigate the effects of working later in life on health and wellbeing.

FUTURE

- We aim to identify age-related changes at the molecular, cellular and physiological levels that lead to an increased risk of ill health over the life course.
- We seek to better understand the relationship between environmental, social and biological factors that determine health and disease in different populations.
- We aim to oversee a dramatic change in the use of large sets of patient and research data, leading to better treatments, the identification of health risks and a greater understanding of the causes of diseases across ages and populations.
- We seek to build stronger interdisciplinary research teams that bring together basic, clinical and population scientists, particularly those working where social science and computational biology meet.
- We aim to make the most of our significant investment in population cohort studies by promoting collaboration between researchers, encouraging greater use of existing data, and ensuring that research findings inform policy and practice.

MAKING AN IMPACT: THE POWER OF MEDICAL BIOINFORMATICS TO IDENTIFY RISK FACTORS FOR DISEASE

A number of epidemiological studies have reported links between increased levels of a protein called lipoprotein-associated phospholipase A2 (Lp-PLA2) and the risk of cardiovascular disease. However, few studies have been large enough to reliably determine the effect of different levels of Lp-PLA2, or how it affects different groups of people (by age, gender or smoking status, for example).

The MRC, the British Heart Foundation and GlaxoSmithKline supported work to bring together and analyse 79,000 individual patient records from 32 studies[7]. It established definitively the link between Lp-PLA2 and cardiovascular disease, showing that the protein was associated with the same risk of heart disease as high cholesterol or blood pressure. Drugs that modify Lp-PLA2 are already in clinical trials.

7 The Lp-PLA2 Studies Collaboration (2010). "Lipoprotein-associated phospholipase A2 and risk of coronary disease, stroke, and mortality: collaborative analysis of 32 prospective studies". *The Lancet* 375 (9725): 1536–1544. doi:10.1016/S0140-6736(10)60319-4

Life course perspective (continued)

HOW

The MRC will continue to support discovery research and invest in population-based studies and underpinning resources. We will work closely with the research councils, Government departments and charity partners to maintain the UK's global lead in research across the life course.

- We will expand health informatics and research involving patient data in the UK through our investment in the Farr Health Informatics Research Institute and the UK Health Informatics Research Network, in particular by **integrating high-throughput 'omics' data with patient and population data**.
- We will capitalise on our long-term funding of UK Biobank and large-scale population cohorts by supporting **data sharing** and best practice, encouraging research collaborations, and promoting **methodological development**, data analysis and linkage and the use of **high-throughput technologies**.
- We will invest in **interdisciplinary population-based** research to address major challenges that will lead to deeper insights into the ageing process, maintaining health and the onset of disease across different populations.
- Capitalising on pioneering MRC research, we will continue to support population studies to address maternal health, children's diseases and **how factors in early life affect later health**.
- We will support interdisciplinary and cross-sector ageing research via the cross-council MRC-led **Lifelong Health and Wellbeing programme**, where collaborative approaches will lead to advances in scientific knowledge, therapeutic and technological developments and impact on policy and practice.
- Our continuing partnerships with a range of research funders, Government Departments and stakeholders will enhance **translation of research outputs into policy and practice**.

Lifestyles affecting health

The UK has one of the highest rates of obesity in children and adults in the world with substantial adverse consequences for health. Some 5m people in the UK suffer from diabetes with a cost to the NHS of approx. £10bn per year. The numbers of people with obesity and diabetes are rising. Behaviours such as diet, how much exercise we do, and consuming tobacco, alcohol or drugs play a major role in influencing health, wellbeing and the risk of chronic diseases. Understanding what drives these choices and how they affect health are key challenges to society, as are developing effective ways to modify the behaviours of diverse social, cultural and economic populations.

OBJECTIVE

To inform the development of effective strategies for promoting healthy behaviour and tackling lifestyles that lead to disease.

NOW

- We play a leading role in coordinating the multi-partner National Prevention Research Initiative and the UK Clinical Research Collaboration (UKCRC) Public Health Research Centres of Excellence, which focus on developing interventions to tackle the risks associated with developing chronic diseases.
- We have significantly increased the capacity for collaborative addiction research by investing in addiction clusters.
- We support an extensive range of research relevant to obesity, diet, physical activity, smoking and inequalities in MRC Units and Universities.
- The MRC Population Health Sciences Research Network has developed internationally recognised methods and guidance for the design and evaluation of lifestyle interventions.

MAKING AN IMPACT: CROSS AGENCY PARTNERSHIPS ACCELERATE ADDICTION RESEARCH

The MRC-funded addiction research cluster in Manchester[8] has been instrumental in the UK Home Office's Drug Data Warehouse[9], an initiative which contains information on one million individuals who misuse drugs. The Manchester team carried out research demonstrating that it is feasible to link separate databases held by the criminal justice system and drug treatment services in a secure and anonymised way. The resource has enormous potential to improve understanding of drug misusers and drug-misusing offenders. Research with the data has already shown that individuals who complete drug treatment programmes halve their convictions[10].

FUTURE

- We aim to identify the **reasons behind lifestyle choices** including the involvement of genetics.
- We aim to better understand the complex relationships between lifestyles, health and **social inequalities**, environmental influences and how these affect health behaviours.
- We aim to understand the factors that are making it difficult to reverse the increasing levels of **obesity** in children and adults, and to develop more targeted interventions.
- We seek to develop new approaches to tackling addiction to tobacco and drugs and to provide authoritative knowledge about the biological and social **harms caused by alcohol**. Where possible we will link this knowledge to specific consumption patterns to provide evidence for new interventions and policy approaches.
- In partnership with Government, international and charity research funders, we seek to **develop and evaluate interventions** designed to improve health and reduce preventable disease.
- We aim to target research to meet needs of users, such as health departments, and successfully **translate research evidence into policy and practice**.
- We seek to strengthen and coordinate interdisciplinary research networks and to develop and **share methodologies** to aid health promotion and disease prevention.

8 Nationally Integrated Quantitative Understanding of Addiction Harms (NIQUAD) http://www.mrc.ac.uk/Ourresearch/ResearchInitiatives/Addictionresearch/DrTimMillar/index.htm
9 The Drug Data Warehouse: Linking data on drug misusers and drug-misusing offenders (home Office Research Report 63, March 2012) http://www.homeoffice.gov.uk/publications/science-research-statistics/research-statistics/crime-research/horr63/horr63-summary?view=Binary
10 http://www.nta.nhs.uk/uploads/theimpactoftreatmentonreconviction.pdf

Lifestyles affecting health (continued)

HOW

The MRC will continue to play a leading role in coordinating and managing multi-funder initiatives and supporting discovery and methodological research involving lifestyles and behaviours that affect health.

- We will support interdisciplinary research into behaviours associated with preventable chronic diseases.
- We will support research addressing people's routes into harmful alcohol consumption and link the drinking behaviours prevalent in the UK across the life course to the harms they cause.
- We will support the early-phase development of population health interventions, which will provide better proof of concept evidence, and increase the effectiveness of subsequent intervention development.
- We will lead multi-partner initiatives, such as the UKCRC Public Health Research Centres of Excellence, aimed at strengthening research capacity in public health, the exchange of knowledge and effective engagement with policy-makers and health service providers.
- We will maintain our investment in high quality research, including through our units, centres and Methodology Hubs, located across the UK. This research will provide critical insights into lifestyle and behaviour that can be adapted for healthier lives.

Environment and health

Environmental factors such as diet, pollution, living conditions and life experiences can affect whether people develop chronic diseases. Learning more about how these environmental triggers affect health will help individuals and policy-makers to manage these risks to health, as well as aiding the development of strategies for the prevention of chronic diseases.

OBJECTIVE

To explore the impact of our environment on health and wellbeing.

NOW

- The MRC has invested in interdisciplinary research to explore the relationship between environmental pollutants and human health to help develop evidence-based policies on harmful exposures.
- We have invested jointly with other funders to better understand the health threats from infectious disease, including pathogens that have the potential to jump from animal hosts to humans.
- MRC units and centres investigate how diet, lifestyle and other environmental factors influence health.
- Through the establishment of facilities for high-throughput science, such as DNA sequencing hubs and the MRC-NIHR Phenome Centre, we have provided new capabilities to analyse biological markers and explore how our genes interact with the environment.

FUTURE

- We aim to better understand how the environment interacts with genes and the biological mechanisms through which they cause and influence chronic disease.
- We seek to advance the measurement of environmental exposures to improve the evidence needed by policy makers.
- The use of existing environmental monitoring data, for example relating to pollution or weather patterns, will contribute to the understanding of the environmental impacts on health.

HOW

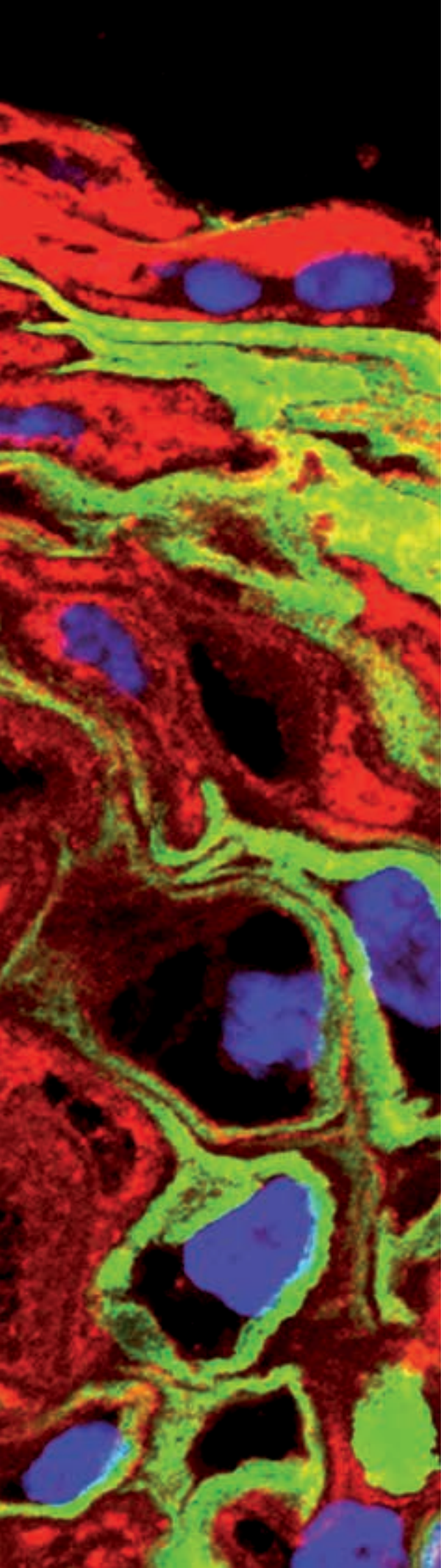
Jointly with partners, we will continue to invest in environment and health research by building on new developments, such as high-throughput technologies or personal devices that can measure an individual's exposure to environmental factors. Understanding the mechanisms by which exposure causes chronic disease will be key.

- We will fund investigators to advance and apply new technologies and methodologies for **exposure measurement**. The development of such new measures will require collaborations between population health scientists and researchers in areas such as physical and engineering sciences, chemical biology and fundamental biomedicine.
- We will support research to identify the biological indicators of environmental exposure, including metabolic and epigenetic changes, with the aim of improving the understanding of **disease-causing molecular pathways**.
- We will **maximise the use of our cohort resources** in research on the effect of the physical and social environment on health.

STRATEGIC AIM TWO

Research to people

BRINGING THE BENEFITS OF EXCELLENT RESEARCH TO ALL SECTIONS OF SOCIETY



The MRC will work with researchers in public and private sectors, regulators, and the breadth of stakeholder communities to ensure that research of the highest quality is translated into tangible benefits for society as a whole.

OBJECTIVES

SECURING IMPACT FROM MEDICAL RESEARCH:

To deliver discovery from data to improve public health and UK wealth; to reshape the medical research and innovation ecosystem to deliver inward investment and promote added value and economic growth; and to deliver fundamental insights that grow medical businesses.

REGULATION, ETHICS, GOVERNANCE AND WORKING WITH DECISION-MAKERS:

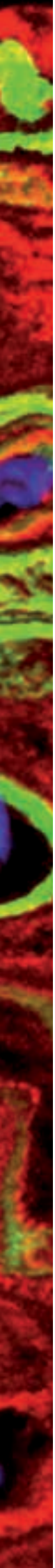
To uphold and guide ethical research practice and the highest standards of research governance; to enhance the regulatory framework for medical research by providing innovative approaches.

ENGAGEMENT:

To enhance engagement and communication with our scientists and partners, policy-makers and parliamentarians, and the public.

IMAGE: HPV in cervical epithelium

A lesion in human cervical epithelium infected with human papilloma virus (HPV). Early viral proteins (green) bind to and reorganise the keratin filaments (red) towards the edge of the cell. Cell nuclei are stained in blue. Certain HPV types, known as high-risk types, cause cervical lesions that can progress to cancer. Cervical cancer is the second most common cancer in women under the age of 35 – in the UK 2,900 women are diagnosed each year – and almost all cervical cancers are caused by infection with high-risk HPV. Studies in MRC National Institute of Medical Research (NIMR) on the life cycle of HPV have provided key information as to how these viruses cause lesions and lead to cancer. A spin-off from this work is the rational selection of biomarkers which can be used to identify disease and to predict the risk of progression.



Securing impact from medical research

There is compelling evidence that investment in medical research leads to significant improvements in both health and economic prosperity[11]. The UK has a world-leading medical research sector, and research funded by the MRC is a vital part of this success[12]. The MRC has proven ways of capturing details about the outputs from, and the impact of, MRC-funded research, and securing this impact is a key element of the MRC strategic plan.

Through a transformative translational research agenda we aim to drive innovation, speed up the transfer of the best ideas into new preventive and therapeutic interventions, and improve the return on investment in fundamental research which forms the basis for translation. This involves further enhancing our knowledge of the fundamental biology of health and disease, including how people vary in the way their disease progresses and how they respond to treatment, as well as supporting the translation of discoveries from fundamental and clinical research into benefits for human health.

OBJECTIVE

To deliver discovery from data to improve public health and UK wealth; to reshape the medical research and innovation ecosystem to deliver inward investment and promote added value and economic growth; and to deliver fundamental insights that grow medical businesses.

NOW

- We have firmly embedded translational research as a key part of our core business, including the establishment of dedicated funding schemes to support this research.
- The Biomedical Catalyst, a £180m partnership between the MRC and the Technology Strategy Board, supports academic and industry scientists to move their research more quickly from discovery to commercialisation.
- We have revolutionised the way we work with industry, including establishing a ground-breaking compound sharing initiative with AstraZeneca.
- Working closely with industry we have established disease-specific stratified medicine consortia bringing together the best researchers across the UK to tackle diseases such as rheumatoid arthritis and diabetes.
- We have introduced new funding approaches to support experimental medicine studies in humans to increase mechanistic insights into disease processes.

FUTURE

- We aim to increase the number of opportunities for commercialisation by expanding the UK academic pipeline of discoveries via the MRC's high-quality translational research programme. These opportunities will:
  - Attract a greater range, number and value of **partnerships with the private sector** including the creation of opportunities for investment by industry.
  - Lead to **increased leverage** of research and development income into the UK.
  - Create **new skilled jobs**.
  - Increase the movement of ideas from the translational programme into **new products and processes**.
  - Result in innovations that will improve productivity and **save healthcare and other costs** across a range of industries and sectors.
- We aim to drive innovations in the collection, analysis and use of research and patient data, which will translate into **improved health interventions and public policies**.
- We aim to take a stratified medicine approach to categorise patients based on genetic and other biological characteristics, which will help to **tailor treatments to individuals**, improving health outcomes for patients and accelerating drug development by companies.
- We will increase the range and number of **partnerships with the public and non-for profit sector**.

HOW

We will build on our existing translational research schemes and continued investment in fundamental, clinical and population research working ever more closely with industry, the Technology Strategy Board, charities, and health service partners. Progress will be facilitated through the increasing availability of safe data including molecular datasets from population cohorts and patients, and NHS health and administrative records.

- We will drive fundamental research discoveries into new treatments and products, and feed clinical results back to the laboratory, with the aim of achieving **better translation** in strategically important areas.
- We will maximise the opportunities for researchers from the **academic and industrial sectors** to work together, including the use of existing resources and infrastructure.
- Through the **Biomedical Catalyst** we, in collaboration with the Technology Strategy Board, will continue to provide funding to academic researchers and businesses to bridge the 'valley of death' – the stage at which ideas, products and technologies must pass proof of concept for clinical trials.

11 Health Economics Research Group, Office of Health Economics, RAND Europe. Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK. London: UK Evaluation Forum; 2008. http://www.wellcome.ac.uk/About-us/Publications/Reports/Biomedical-science/WTX052113.htm

12 The MRC contribution to health relevant research spend in the UK is outlined in the UKCRC report at http://www.ukcrc.org/index.aspx?o=3643 An example of the quality of the UK science base can be found in the international citation analysis at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32489/11-p123-international-comparative-performance-uk-research-base-2011.pdf

- We will build on rich genome, phenome, imaging and other information, linked to healthcare data to drive forward our ambitions in **stratified medicine** in partnership with industry. This will include targeting diseases that are more difficult to deal with and enriching human science through methodologies and tools, including adaptive trial designs and robust biomarkers.
- Working with the Office for Strategic Coordination of Health Research (OSCHR) partners we will develop ways to integrate new **molecular pathology** technologies into healthcare, using molecules within tissues or body fluids to diagnose disease. We will use high-throughput 'omics' and imaging technologies to improve clinical phenotyping, and feed this information back to inform research.
- We will target further investment towards **experimental medicine** approaches, addressing the big challenges in the understanding of disease mechanisms in humans, and engage with industry to stimulate partnerships in this area.
- We will continue to support partnership initiatives that provide robust evidence to inform health policy and practice (see Lifestyles affecting health).

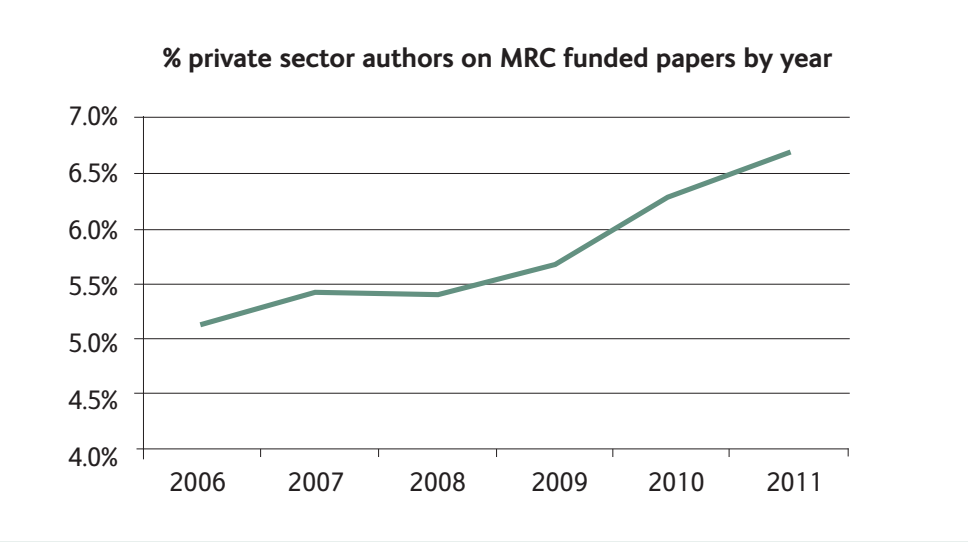
MAKING AN IMPACT: MRC SPIN OUT REVOLUTIONISES RATIONAL DRUG DESIGN

MRC spin out company Heptares Ltd. formed in 2007 and has since built a unique capability for discovering molecules that target G-Protein Coupled Receptors (GPCRs), an important class of drug target that has proven difficult to target in the past. Around 40 per cent of all marketed drugs act on GPCR proteins (including beta blockers for heart conditions and H2 agonists to control stomach acid). Heptares has secured agreements with pharmaceutical companies to study specific GPCRs worth an estimated £450m, and has achieved key milestones in this programme.

PROXIMITY TO DISCOVERY: PRIVATE SECTOR INVOLVEMENT IN MRC RESEARCH IS HIGH AND RISING

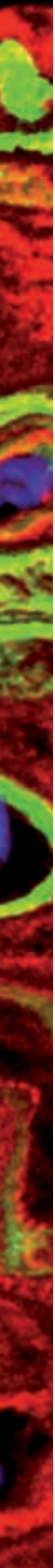
MRC data shows that 8.5 per cent of MRC-funded publications have at least one author from industry – significantly higher than the 1.3 per cent that the International Comparative Performance of the UK Research Base: 2011[13] report states for the UK research base as a whole.

The proportion of private-sector authors on MRC funded, peer-reviewed papers has increased from around 5 per cent in 2006 to almost 7 per cent in 2011 (and we expect this to increase further as our 2011 data is partial).



The 'proximity to discovery' is key factor for industry when deciding on locations for investment. For example, the high quality research environment in Cambridge, including the MRC Laboratory for Molecular Biology and Wellcome Trust-MRC Institute of Metabolic Science, were key drivers for AstraZeneca's decision to invest £330m into a new global research and development centre in Cambridge.

13 http://www.bis.gov.uk/policies/science/science-innovation-analysis/uk-research-base



A visionary future: Stratified medicine

Advances in diagnostic techniques such as imaging, genetic tests and the identification of biological indicators mean that we can now more accurately define groups of patients and use this 'stratification', to improve the development of treatments. Stratified medicine (sometimes called 'personalised' or 'precision' medicine) has generated huge interest from industry[14] and is seen as central to the progress of healthcare[15].

Stratified medicine approaches are already used in some cancer treatments (Herceptin for Her2-positive breast cancer, for example, and Erbitux for EGFR-positive secondary bowel cancer). The MRC has developed new research consortia made up of academic and industry partners to focus on diseases such as arthritis, respiratory disease and diabetes. These will advance stratified medicine, promote the discovery and development of new molecular and cellular approaches to diagnosing disease and work closely with the Technology Strategy Board in this area.

A visionary future: Experimental medicine

Experimental medicine refers to research mostly in humans that provides new insights into disease mechanisms or establishes whether new treatments should be pursued further. It precedes and informs later clinical trials, but can also generate new data to inform fundamental research. The MRC has invested to strengthen experimental medicine research in the UK, foster more ambitious human studies in academia, and increase partnerships between academia and industry, closely coordinated with other medical research funders. Examples of work in this area include studies on steroids called glucocorticoids which have advanced our knowledge of metabolic syndrome[16] and research to better understand airway inflammation in asthma[17]. They aim to discover more about underlying disease but also involve private sector partnerships to translate discoveries into treatments.

14 https://connect.innovateuk.org/c/document_library/get_file?p_l_id=1720995&folderId=5719347&name=DLFE-53534.pdf
15 Hamburg MA, Collins FS. The path to personalized medicine. N Engl J Med2010;363:301-4
16 11ß-Hydroxysteroid Dehydrogenase 1: Translational and Therapeutic Aspects *Endocrine Reviews* April 23, 2013 doi: 10.1210/er.2012-1050 http://edrv.endojournals.org/content/early/2013/04/22/er.2012-1050.abstract
17 Treatment strategies for allergy and asthma. *Nature Reviews Immunology* 8, 218-230 (March 2008) | doi:10.1038/nri2262 http://www.nature.com/nri/journal/v8/n3/full/nri2262.html

Regulation, ethics, governance and working with decision-makers

For academic and commercial research to be effectively carried out and translated into patient benefit, we need regulations that are proportionate to risks and harmonised across organisations. We also need to ensure that researchers have appropriate access to healthcare systems and related safe datasets and that the public has trust in research governance. Working with partners, the MRC plays an important role in influencing regulation and governance in a way that facilitates research while maintaining the highest ethical standards.

OBJECTIVE

To uphold and guide ethical research practice and the highest standards of research governance; to enhance the regulatory framework for medical research by providing innovative approaches.

NOW

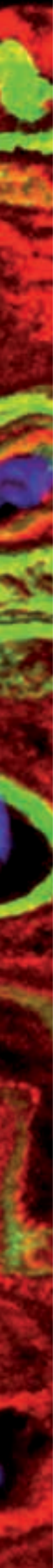
- The MRC supports the recent establishment of the Health Research Authority (HRA) and is building close working relationships with the HRA and other organisations involved in research governance across the UK – through secondments to projects on the delivery of guidance and training for researchers, for example.
- We are working in partnership with other funders, academics and industry to influence the direction of EU legislation relating to clinical trials and data protection with the aim of facilitating clinical research regulation.
- The MRC aims to ensure that innovative developments in research are aligned with best practice in the ethical conduct of research – for example, we are working with the Wellcome Trust on a joint framework on how health-related findings in research should be addressed.
- We are working, as part of the UK Bioscience Sector Coalition, to ensure that implementing the changes to animal research regulation resulting from EU directive 2010/63 leads to a reduction in unnecessary bureaucracy while maintaining high welfare standards.
- The MRC is a signatory of the 2012 UK Research Integrity Concordat and is working in partnership with other research councils to strengthen the culture of research integrity via improved guidance, training and accountability.

FUTURE

- Through effective partnerships we aim to ensure that the UK **regulatory landscape**, linked to the EU framework, is **risk proportionate and harmonised** – allowing research to be delivered in a more timely, less resource-intensive environment.
- We aim to increase opportunities to deliver on the rich potential of UK (and global) patient and population **data, and associated biological samples**, while ensuring the highest standards of ethics and governance to promote public confidence in this key area.
- By engaging with the HRA, the Medicines and Healthcare products Regulatory Authority (MHRA) and oversight bodies across the UK and EU, we aim to support the development of a **harmonised system of approval in the UK and EU**; ensuring clear consistent guidance is easily available to researchers navigating this system.
- We aim to provide effective systems and guidance to researchers to promote **transparency of outcomes and sharing of data** from MRC-funded research.

HOW

- We will work in partnership with others to effectively bridge between researchers and regulators/policy-makers to ensure legal and regulatory frameworks are developed with a clear understanding of the medical research landscape.
- The MRC will work with others to increase communication, engagement and the involvement of the public in approaches to regulation and governance involving people and animals.
- We will facilitate access to patient and population data and biological samples, whilst maintaining the highest standards of safety and security for data use. We will lead on the concept of "safe" data.
- We will ensure that researchers can access up-to-date and clear guidance on the conduct of research and will work across the sector to strengthen the integrity of research.
- We will continue to promote a culture of openness about the use of animals in research and dialogue with the public about this issue.



Engagement

We have a duty to engage with the public and other groups, to give an account of our research and to ensure that public views and concerns are reflected in our decision-making.

OBJECTIVE

To enhance engagement and communication with our scientists and partners, policy-makers and parliamentarians, and the public.

NOW

Our engagement and communication activities make our research more accessible to many different groups of people.

- We seek public input when reviewing major public health and translational research investments, and ensure that the public is actively engaged in key areas, for example on the use of patient data through the Farr Institute for Health Informatics Research.
- We help the public understand our scientific findings and assess the impact these may have on their own lives, on the economy and on society as a whole through direct access to our scientists at events, and by providing understandable information online and in the media.
- We support the need for evidence-based policy and decision-making through the timely provision of accurate, up-to-date information on policy-relevant topics.
  We provide expert advice and information about our research, and share the results and impacts of our work.
- We work with partners to improve our effectiveness and our value for money, sharing best practice and maximising the use of resources.

FUTURE

Communication channels have proliferated in recent years, allowing people to access the information they want or need via a variety of routes and at times that suit them. We need to be able to work in this ever-changing environment in ways that are flexible and responsive to the dynamic nature of research and society, at the same time increasing awareness and understanding of the MRC and the impact of our research. Our approach will:

- Support the strategic needs of the MRC by focusing on areas where we can make the greatest impact, for example by supporting our strategies in medical bioinformatics and partnerships with industry and charities.
- Deploy our resources cost-effectively.
- Leverage support through partnerships and collaborative working.

HOW

The MRC will:

- Explore current and emerging **digital technologies** to communicate with groups through the channels they prefer in a cost-effective manner.
- Understand and reflect **patient and public views** on important topics using a range of mechanisms for public dialogue and consultation.
- Work in partnership with **charities** to garner **patients' perspectives** on our work, and to use these to make our research more meaningful.
- Work with **industry**, biotech and other companies to showcase our partnerships with them and ensure that we are aware of their needs.
- Work with colleagues in the **Department for Business, Innovation and Skills** to demonstrate the relevance and value of our work to all Government departments.
- **Deliver value for money** and share best practice and resources by working collaboratively with our many partners, particularly Research Councils UK, the Association of Medical Research Charities and other medical research funders.
- Enhance and extend our engagement with the public by providing resources for researchers to **communicate with the public**, and rewarding and recognising them for doing so.

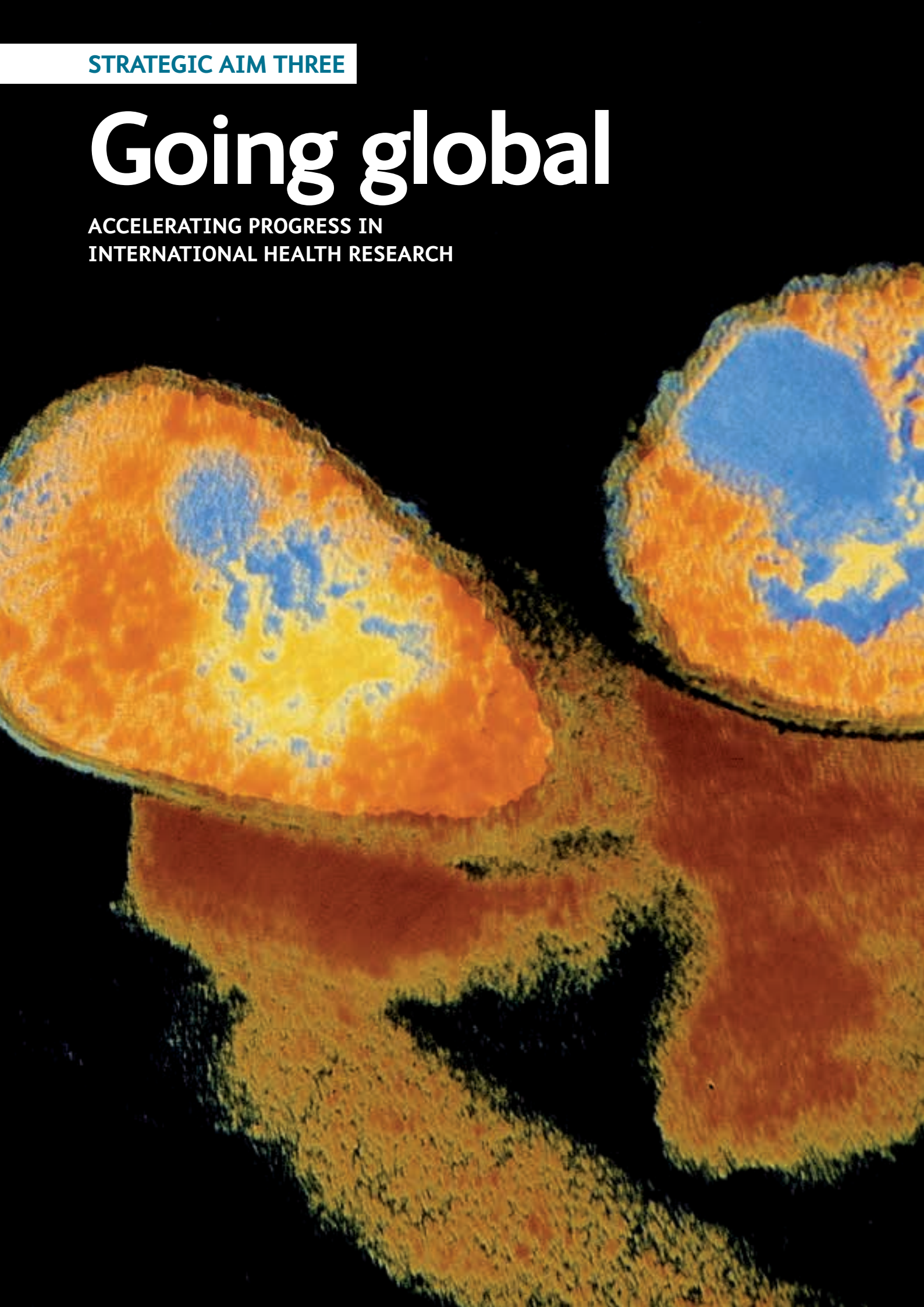
MAKING AN IMPACT: MRC SCIENTISTS INSPIRE A NEW GENERATION

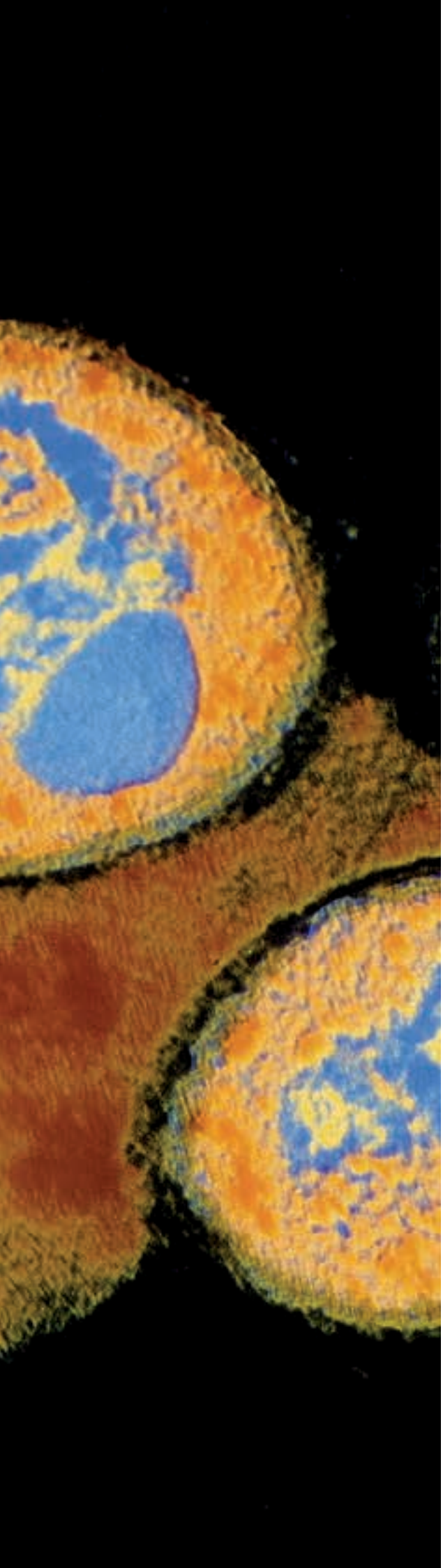
Researchers at the MRC Human Genetics Unit at the University of Edinburgh collaborate with nearby Broughton High School by sharing images and stories about research, and giving talks about life as a scientist and careers in science. Dave Cockburn, Faculty Head of Science at the school, said of the partnership: "This relationship has been extremely valuable for the staff and the students. The percentage of students taking two sciences in 2009/2010 was 16 per cent. In 2010/11 we continued with the project and the percentage is now 40 per cent. These figures speak for themselves and they would suggest the talks have helped to get more students studying two or more sciences."

STRATEGIC AIM THREE

Going global

ACCELERATING PROGRESS IN INTERNATIONAL HEALTH RESEARCH





The MRC will use its experience, expertise and resources to encourage partnership working in the international community to tackle important and challenging research goals.

OBJECTIVES

INTERNATIONAL PARTNERSHIPS AND SHAPING THE AGENDA:

To provide international leadership in partnerships which enhance the competitiveness of the UK knowledge and health base and to influence the international research agenda.

GLOBAL HEALTH:

To support global health research that addresses the inequalities in health which arise particularly in developing countries.

IMAGE: Mycobacterium tuberculosis bacteria
Mycobacterium tuberculosis is the cause of tuberculosis (TB) in humans. It continues to claim many lives across the globe, in particular in developing countries and patients with AIDS. One hundred years ago the MRC was established to tackle TB. When the first antibiotic cure, streptomycin, was discovered in 1943, the MRC set up large-scale randomised clinical trials to assess its effectiveness as a treatment. While the antibiotic killed mycobacterium tuberculosis, the bacteria proved sufficiently resourceful to rapidly evolve defences against this line of attack. Today, despite the development of many other antibiotics, resistance to drug treatment proves the single greatest challenge to eliminating TB once and for all.

International partnerships and shaping the agenda

Research is an international activity and the landscape for research cooperation across the world is ever changing. There are new global challenges to tackle and potential new research partnerships arising as governments in emerging economies increase their investment in science and innovation. The MRC has opportunities to form strategic partnerships that will lead to world-leading collaborative research, and to enable UK scientists to engage with the best minds, ideas and resources wherever they are located. Working in partnership allows us to leverage resources that increase the value of our work and lead to greater impact.

OBJECTIVE

To provide international leadership in partnerships which enhance the competitiveness of the UK knowledge and health base and to influence the international research agenda.

NOW

- We provide leadership in policy areas, including peer review, open access publishing and research integrity, to gain better alignment with UK strategic needs and in international funding activities.
- Throughout the EU's seventh framework programme (FP7) the MRC has been the UK lead on the health theme, providing the national contact point for UK health academics. We have helped to ensure that the UK was the top beneficiary of EU funding for health through the FP7 co-operation programme and the Innovative Medicines Initiative.
- The MRC led the development of the Strategic Research Agenda of the European Joint Programme Initiative (JPI) on Neurodegenerative Diseases and led on research mapping for the Strategic Research Agenda of the JPI on microbial challenge.
- As part of our commitment to 'Going global' the MRC has taken on the management of the research council offices in India, China and the United States to strengthen the UK's international research links.

MAKING AN IMPACT: UK PERFORMANCE IN THE SEVENTH FRAMEWORK PROGRAMME

The Seventh Framework Programme (FP7) was the main mechanism used by the European Commission to fund research across Europe during the period 2007-2013. As the UK lead on the FP7 Health Programme Committee, the MRC took a pro-active approach to shaping the framework programme in consultation with the Department for Health and the Office for Life Sciences, and provided the National Contact Point (NCP) for health, providing guidance on FP7 calls to the UK academic community. Based on grant agreements signed prior to March 2013, the UK was the top beneficiary of funding in health research receiving a total of €653m. The MRC also represents the UK on the Member States representative group of the FP7 Innovative Medicines Initiative (IMI), which supports collaborative academia-industry research projects to boost pharmaceutical innovation in Europe. In the first five IMI calls, UK scientists received over 30% (€120m) of IMI funding – far higher than any other member state – with UK participation in all but two of the projects funded.

FUTURE

The MRC will continue to use its experience, expertise and resources to encourage international partnerships that tackle important and challenging research goals.

- We aim to capitalise on the MRC's reputation for excellence, authority and independence to **influence the international research agenda** and provide leadership in areas of research policy.
- We will **leverage funds** from partners to enhance our investments and increase the scale of the challenges that we can tackle.
- We will seek to **influence the regulatory environment** for research that is subject to EU or other legislation, or to international guidelines.
- We will facilitate UK researchers' **access to international research infrastructures**.

HOW

Our objective is to encourage opportunities for UK scientists to engage with the best researchers in the world.

- We will invest in partnerships to carry out research that the UK cannot deliver alone, for example through the Human Frontiers Science Programme, the International Agency for Research on Cancer, and the European Molecular Biology Laboratory.
- We will work through the international framework of Research Councils UK (RCUK) to coordinate our international strategies with other research councils and build on the work of the RCUK offices overseas.
- Working with UK partners we will monitor and attempt to amend EU legislation in line with UK policy, and work through Science Europe to coordinate policy development with other European countries.
- We will explore opportunities for strategic funding partnerships with research funders in other countries and facilitate new research initiatives for instance with emerging economies such as India or China.
- We will ensure that the MRC retains influence and a high profile by networking with the heads of international research organisations, policy-makers and public–private partnerships.
- We will influence the Horizon 2020 agenda to address key needs such as antimicrobial resistance and research into dementia, building on the work of the JPIs in these areas.

Global health

The MRC has invested in high-quality research to bring the benefits of biomedical research to populations across the world for more than 80 years. We have worked in partnership with local or regional research networks, governments and other research funders to build up a substantial global health portfolio of approximately £50m per year. This portfolio includes a contribution of £9m per year from the UK Department for International Development, a longstanding partnership which ensures that the UK's investment achieves maximum global health impact.

Funding research to improve health globally delivers on the UK's commitments to international development while also exploring research questions of relevance to everyone. The changing burdens of disease across the world, for example, the increasing emergence of chronic diseases such as heart disease and diabetes in developing countries, bring new opportunities for the MRC's global health research to benefit health both in the UK and internationally.

OBJECTIVE

To support global health research that addresses the inequalities in health which arise particularly in developing countries.

NOW

- The MRC has long-standing units in The Gambia and Uganda. These are major centres of excellence which work with local and regional networks to conduct world-class research spanning fundamental laboratory-based work to social science studies and large-scale clinical trials.
- Recognising the increasing burden that chronic non-communicable diseases place on global public health, the MRC is a founding partner of the Global Alliance for Chronic Diseases; a group of international health funders which has, as its first joint activity, established a global programme of hypertension research.
- In partnership with DFID and the Wellcome Trust we are investing in global health intervention trials aimed at improving the health of the most vulnerable in society.

MAKING AN IMPACT: MRC SUPPORTED RESEARCH HAS LED TO MAJOR ADVANCES IN INTERNATIONAL PUBLIC HEALTH RESEARCH

Results from the ARROW clinical trial in Zimbabwe and Uganda, jointly supported with the Department for International Development, have shown that children on HIV treatment can be safely monitored without the need for expensive routine laboratory tests. These findings mean that treatment can be given much more cheaply, which may help more children to get access to life-saving care.

The ground-breaking FEAST trial showed the detrimental effect of reviving children in shock with the most severe infections with fluid 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.

FUTURE

We will build on our existing strengths to carry out world-class research and deliver its benefits to global communities. Our vision includes but also extends beyond our successful long-term investments in Africa.

- We aim to continue our leading role in tackling **infectious diseases**, which impact heavily on the health and wellbeing of populations in resource-poor settings.
- We aim to strengthen investment in **non-communicable diseases**, such as cardiovascular disease, type 2 diabetes and respiratory conditions, and explore opportunities to fund mental health research in resource-poor settings.
- We seek to develop our investment in the translation of research findings into **health systems** to ensure that the outcomes of our research can be better implemented into practice, providing evidence for policy-makers and other users.
- We aim to explore opportunities to fund interventions and implementation research in **child and maternal health**, including the time surrounding the birth, the early stages of a child's life and nutrition research.

HOW

We will leverage funding and work in partnership to accelerate progress with major infectious and non-communicable diseases.

- We will continue our commitment to supporting and developing existing centres of excellence and regional networks in Africa, building on key UK strengths in methodology research and technology.
- Through our renewed concordat partnership with the UK Department for International Development, we will together invest over £90m over five years in excellent research with potential to address international development goals.
- We will support research across the pipeline from fundamental research in the laboratory through to research into how health systems can use interventions in order to improve vaccinology and disease elimination.
- We will continue to strengthen our portfolio of research into HIV/AIDS, malaria, tuberculosis and neglected tropical diseases.
- We will expand our commitment to global health research which delivers implementable results by developing partnerships to fund global health clinical trials, including the European Developing Countries Clinical Trials Partnership and the DFID/MRC/Wellcome Trust global health trials funding scheme.
- We will capitalise on the opportunities made available by the establishment of the Global Alliance for Chronic Diseases and explore which interventions for chronic diseases are likely to be most effective in resource-poor settings and how these might be put into practice.
- We will support a multi-funder programme to research how health systems in low and middle-income countries can deliver improved health outcomes, promoting the translation of research findings to vulnerable populations.

STRATEGIC AIM FOUR

Supporting scientists

SUSTAINING A ROBUST AND FLOURISHING ENVIRONMENT FOR WORLD-CLASS MEDICAL RESEARCH

The MRC aims to strengthen the UK research base to enable the scientific community to respond effectively to current and future grand challenges in medical research.

OBJECTIVES

CAPACITY AND SKILLS:

To train and develop the next generation of biomedical research leaders by supporting outstanding individuals at crucial points in their research careers, aligned to national strategic skills objectives.

RESEARCH ENVIRONMENT:

To provide a world-class research environment for medical research.

Capacity and skills

The MRC is about the people we nurture and support to become tomorrow's leaders in discovery science. We will continue to prioritise investment in skills to develop and foster innovative and creative researchers. We will meet national strategic skills needs, and ensure an internationally competitive research base for the UK which can respond to future challenges in human health and ensure that the UK is the location of choice for investment and growth.

OBJECTIVE

To train and develop the next generation of biomedical research leaders by supporting outstanding individuals at crucial points in their research careers, aligned to national strategic skills objectives.

NOW

- We play a key role in ensuring a highly skilled workforce for UK medical research by supporting more than 5,700 research staff, 400 training fellows and 1,900 PhD students across the full spectrum of health disciplines, many working with industry. MRC Units, Centres and Institutes make significant contributions to training and the development of future research leaders.
- The MRC engages with partners such as NIHR, charities and industry to understand needs for skills at a national level and meet these by supporting, for example, strategic skills fellowships in areas such as population health research, methodological research and advanced skills for working with animals.
- We fund innovative approaches to training. For example, the MRC and Asthma UK Centre in Allergic Mechanisms of Asthma is a unique environment in which to train fundamental and clinical researchers, involving two universities and charity and industry partners.
- The MRC stimulates collaborative research across academia and industry through a range of schemes including MRC Industrial CASE studentships and partnership awards for research fellows.

FUTURE

- The MRC will enrich support for future research leaders through flexible support at critical stages in research careers, and ensure that pathways to career development are clear and have appropriate support networks.
- We will enhance support for strategic skills, wherever possible in partnership so that we can ensure alignment and connections with other funders, industry, the NHS and other stakeholders.
- The MRC will dramatically improve engagement between academic and industry researchers to make the UK an attractive location for industry to operate.
- We will work with partners to deliver a vision and framework for non-traditional research careers.

MAKING AN IMPACT: THE MRC SUPPORTS THE EXCELLENCE OF CLINICAL RESEARCH IN THE UK.

A 20-year follow up of MRC clinical training fellows revealed that nearly all (96 per cent) are still actively engaged in research, close to 40 per cent at professorial level and 40 per cent as NHS consultants[18]. 20 per cent were awarded Fellowships of the Academy of Medical Sciences, which are widely accepted as markers of international research excellence. Within the NHS, MRC clinical training fellows are providing a manpower 'research engine' for the UK to undertake clinical research and engage with pharmaceutical industry at a time when medicine is a key contributor to economic growth.

HOW

The MRC will continue to support outstanding individuals and invest in areas that have the most potential to deliver excellence and innovation for human health. We will ensure that the MRC's investment in training is focused on developing a highly skilled cadre of researchers able to respond to new research challenges and who are **comfortable working alongside researchers from other disciplines**. We will achieve this through:

- Establishing with partners such as the Academy of Medical Sciences a revised **career framework for non-clinical scientists**, including those pursuing non-traditional routes.
- Ensuring that strategic skills for medical research are reviewed in partnership with industry, including consideration of evolving areas of strategic importance where interdisciplinary approaches are paramount, for example experimental medicine and medical bioinformatics.
- Establishing a working party with industry to **achieve a step change in engagement between academic and industry researchers**.
- Expanding our investment in **medical bioinformatics** with a focus on supporting career opportunities in medical research for computational scientists, technologists, and programme leaders.
- Promoting the diversity of our research base and ensuring enhanced **career support and mentorship** for researchers at all stages of their career.
- **Streamlining support mechanisms** to ensure maximum flexibility and minimum administrative burden.

18 http://bmjopen.bmj.com/content/2/4/e001792.full

Research environment

The global landscape for research is fluid, dynamic and intensely competitive. Unlocking research opportunities requires highly technical and often expensive infrastructure that delivers value over a sustained period of time and across a wide range of disciplines. Coordinated and partnership investment is important to make the most of resources and increase the reach and impact of investments through the sharing of equipment and the co-creation of knowledge and skills. Interdisciplinary approaches will contribute to the development of technologies that will accelerate medical discoveries and provide opportunities for industry investment.

OBJECTIVE

To provide a world-class research environment for medical research.

NOW

- We are establishing the Francis Crick Institute, a unique partnership between the MRC, major charitable funders, and London universities which will provide a major new national biomedical research institute for the 21st century.
- We have developed new world-class facilities for the internationally renowned MRC Laboratory for Molecular Biology, including adaptable space for cutting-edge equipment, which will enhance networking and research collaborations.
- We are transforming the way in which we support research by fully integrating the majority of our MRC units within UK Universities.
- We have invested in partnerships to create innovative environments and cutting-edge facilities for medical research, including the Scottish Centre for Regenerative Medicine, the Research Complex at Harwell, the MRC-University of Glasgow Centre for Virus Research, the MRC-PHE Centre for Environment and Health in London and the MRC Centre for Neuropsychiatric Genetics and Genomics in Cardiff.
- We have also invested close to £25m in next-generation optical microscopy (in partnership with the Biotechnology and Biological Sciences Research Council and Engineering and Physical Sciences Research Council) so that the UK can tackle key research questions in biomedicine and fundamental biology, and to support the interdisciplinary partnerships that drive technological innovation.

FUTURE

Researchers require access to state-of-the-art technology and skills to carry out cutting-edge research and generate scientific discoveries that transform the knowledge base.

- We aim to ensure that core technologies are sustainable and to deliver local, regional, national or international infrastructure which increases access to cutting-edge technologies in a cost effective way.
- We seek to dramatically improve engagement between academics and industry through new and flexible approaches to joint working, which can lead to the co-creation of knowledge and skills.

THE FRANCIS CRICK INSTITUTE

The Francis Crick Institute is a new medical research institute established by six of the UK's most successful scientific and academic organisations – the Medical Research Council, Cancer Research UK, the Wellcome Trust, University College London, Imperial College London and King's College London. Together they will invest around £650 million to build and equip the institute ready to make a major impact when it opens in 2015. When it is fully operational, it will be the largest such institute under one roof, employing 1,500 staff, including 1,250 scientists, with an annual operating budget of more than £100 million. The institute will establish a unique environment in which researchers can pursue discovery 'without boundaries' and work creatively across disciplines to advance UK science and innovation. It aims to attract and train future scientific leaders from across the world and help them to establish long-term research programmes in the UK.

Research environment (continued)

HOW

The MRC will:

- Work with stakeholders, including industry, charities, the NIHR and health departments, and other funding bodies, to further develop the long-term vision for how to deliver sustainable medical research infrastructure in the UK. This will include the best environments for clinical researchers and **experimental medicine studies in humans**.
- Work with research councils, funding councils and charities to identify and respond to national gaps in medical research capability, and ensure that we align this work with the ambitions of the strategic framework for capital investment in the **RCUK report Investing for growth**[19].
- Work in partnership with universities and other funders to **strengthen the interdisciplinary environments** required to tackle big challenges in medical research, maximising the opportunities provided by the Francis Crick Institute and MRC institutes, units and centres.
- **Strengthen consortia approaches** that bring together the best scientists regardless of institution and sector and promote industry engagement.
- Stimulate interactions between medical researchers and those in physical, engineering, mathematical and computational disciplines to accelerate **technology solutions** for the future.
- Increase the reach and impact of investments through sustainable regional and national approaches to infrastructure provision and management.

MAKING AN IMPACT: INTERDISCIPLINARY RESEARCH

'Interdisciplinary' research carried out by teams, or individuals, integrates information, techniques, perspectives and/or theories from two or more 'disciplines', or bodies of specialised knowledge. The aim is to advance understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice.

For example, MRC researchers have been responsible for some of the most transformative advances in medical imaging, a field that requires working across traditional disciplinary boundaries in medicine, physics, mathematics and engineering. MRC research has resulted in, or underpinned the development of X-ray crystallography for protein structure determination[20], PET imaging[21], magnetic resonance imaging (MRI)[22], laser scanning confocal microscopy[23], and optical projection tomography[24]. These techniques are essential tools for the clinician and the laboratory researcher, with almost 5 million diagnostic MRI and computed tomography scans carried out in the NHS each year, and optical laboratory microscopy now providing images at the molecular level.

To create and grow collegiate interdisciplinary environments the MRC has embedded Units and supported Centres within Universities, as well as maintained its own Institutes with the critical mass and long-term funding to tackle challenging problems in medicine. The MRC Laboratory of Molecular Biology is often cited as the world's most successful biomedical research institute[25], and this success has in part been built through recruitment of chemists, computer scientists, physicists and engineers to work on biomedical problems. One example of this is the world-leading synthetic biology research programme led by Jason Chin, which uses innovative chemistry to re-engineer biological systems[26]. Synthetic biology has been highlighted by the Minister for Science as one of the "Eight Great Technologies" in which the UK has advantages that may be leveraged for economic growth[27].

19 http://www.rcuk.ac.uk/Publications/policy/Pages/CapitalInvestment.aspx
20 Dr Max Perutz and Sir John Kendrew (MRC Laboratory of Molecular Biology) were awarded the 1962 Nobel Prize in Chemistry having applied X-ray crystallography to study the structures of globular proteins such as haemoglobin and the immunoglobulins (antibodies).
21 The MRC's decision to install the world's first hospital-based cyclotron unit at Hammersmith Hospital in the 1950s helped pave the way for the development of PET c.f. Wellcome Trust Portfolio Review of Functional Brain Imaging 1990-2009 (2011) http://www.wellcome.ac.uk/stellent/groups/corporatesite/@policy_communications/documents/web_document/WTVM052606.pdf. The cyclotron at Hammersmith is still a the centre of a world-leading imaging facility, now a commercial partnership between Imperial College, Kings College, University College London, and the MRC (Imanova Ltd. http://www.imanova.co.uk/).
22 MRC supported Sir Peter Mansfield's work which led to developing the first clinically useful magnetic resonance imaging equipment in 1978/9, and the 2003 Nobel Prize for Physiology and Medicine.
23 Brad Amos, John White, Richard Durbin and Mick Fordham working at the MRC LMB in the 1980s are credited with the development of laser scanning confocal microscopy, commercialised by Bio-Rad and now used in laboratories across the world http://www.ncbi.nlm.nih.gov/pubmed/14519550
24 Optical projection tomography (OPT) is a relatively new imaging technique, developed by James Sharpe at the MRC Human Genetics Unit, in 2002. OPT can accurately image the development of 3D structures by projecting light through a whole specimen.
25 A Nobel Prize–Winning Culture (Science, 2011) http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2011_07_08/caredit.a1100063
26 http://www2.mrc-lmb.cam.ac.uk/research/protein-and-nucleic-acid-chemistry/centre-for-chemical-and-synthetic-biology/
27 Eight Great Technologies, David Willetts (Policy Exchange, 2013) http://www.policyexchange.org.uk/images/publications/eight%20great%20technologies.pdf

Glossary of terms

Adaptive trial design: A way of designing a clinical trial that uses the trial's accumulating data to design or modify the next step.

Adult stem cell: Cells found in the body after development which can divide indefinitely or develop into some other types of cell. There are many different types of adult stem cell, each of which can replenish dying cells in the organ or tissue in which they are found.

Brain Body axis: The relationship between mental and physical health.

Biomaterial: A material which interacts with biological systems (eg cells, proteins or DNA), such as the scaffolds on which researchers grow new tissue.

Birth cohort: A group of people born at a defined time. Studying the way that people in birth cohorts change over time allows researchers to understand how lifestyles and the environmental influence health and identify risk factors for disease.

Chemical biology: An area of science which spans the fields of chemistry and biology. It involves the application of chemical techniques and tools to the study and manipulation of biological systems.

Chronic disease: A long-lasting disease such as heart disease, diabetes, cancer or arthritis. Chronic diseases can be infectious or non-infectious. HIV/AIDS is an example of an infectious chronic disease.

Clinical research: Research done in people to determine the safety and effectiveness of new treatments, diagnostic techniques, and ways to prevent or relieve the symptoms of disease.

Computational biology: A scientific discipline which develops and uses computer programs to analyse data, and create mathematical models and simulations to study biological, behavioural and social systems.

Cohort: A group of people that is studied by researchers over a period of time (see also birth cohort and population cohort).

Developmental biology: The study of the processes by which humans grow and develop, including how cells grow and become specialised to form tissues and organs.

Discovery science: Research that increases the fundamental understanding of health or disease, which can be conducted in a laboratory, clinical setting or in populations.

Disease mechanism: The cause of a disease at a molecular or cellular level. Knowing more about disease mechanisms helps researchers to develop treatments or preventative strategies.

Epidemiology: The study of the causes of diseases and how they spread in populations. Epidemiology identifies the risk factors for diseases and so is useful in their prevention.

Epigenetics: The study of, or the way in which, the production of proteins from genes is affected by processes other than the underlying DNA sequence. These processes can be inherited, or changed by the environment throughout life.

Experimental medicine: Research in healthy people or patients to investigate disease mechanisms or to test for the first time whether new treatments work. This kind of research comes before and informs the development of late-phase clinical trials, but it can also generate new data which feeds back into research in the laboratory.

Fundamental research: Research carried out, often in the laboratory, with the aim of better understanding the fundamental principles underlying biological mechanisms. Such research might not yield immediate health or economic benefits, but it is often the basis of discoveries that are successful in the longer-term.

Genome/genomics/genomic data: A genome is a person's complete set of genetic material. Genomics is the study of full or partial genomes using technologies such as genetic sequencing. Genomic data is the data that arises from such studies.

Health informatics: The use of patient records and other population data in research to improve treatments, health care and identify causes of disease.

High-throughput technologies: The use of automated technologies to analyse biological samples at a speed and scale not possible with conventional laboratory methods.

Human embryonic stem cell: A cell taken from a very early-stage human embryo that can either divide indefinitely (self-renew) to form more human embryonic stem cells, or develop (differentiate) into all the different types of cell that make up the human body.

Implementation research: The study of how best to get the results of research used in 'the real world'. For example, researchers may design a vaccine, but implementation research will determine how to get it to people.

Induced pluripotent stem cell: A type of stem cell produced by reprogramming a conventional adult cell. They are similar to human embryonic stem cells and can form all types of tissues, although scientists are still assessing their characteristics and whether they can be used clinical studies.

Inflammation: An immune response to irritants, pathogens or damaged cells which results in swelling, pain, heat and redness. Chronic inflammation plays a role in age-related diseases such as arthritis.

Interdisciplinary research: Research that integrates information, techniques, perspectives and/or theories from two or more research disciplines. The idea is to solve problems or make discoveries that would be out of reach of a single discipline.

Medical bioinformatics: Research using very large biological and health datasets including linking genomic information with patient records.

Metabolism: The chemical reactions that occur within the human body to sustain life (eg the breaking down of food for energy and the creation of new cell components such as proteins).

Methodological research: the study of how best to design, analyse and evaluate medical and health research.

Microbiome: The community of microbes that occur naturally in the human body. The make-up of the microbiome is increasingly being recognised as playing an important role in human health.

Molecular pathways: A series of chemical reactions that take place inside a cell. Components of molecular pathways that play a role in disease are important targets for developing drugs.

Neglected tropical diseases: Infectious diseases which disproportionately affect people in low-income countries and which have received less research investment in the past.

Neurodegenerative disease: Progressive brain diseases characterised by the death or neurons or their failure to function. Diseases such as Alzheimer's, Parkinson's and Huntington's are neurodegenerative.

Non-communicable diseases: Diseases which cannot be passed from one person to another, such as heart disease, stroke or asthma. They differ from chronic diseases in that some chronic diseases are infectious, and some non-communicable diseases last for a short period of time.

'Omics' technologies: High throughput technologies to analyse biological samples, for instance genomics (the study of a person's DNA), proteomics (the measurement of proteins in cells or tissues), metabolomics (the measurement of metabolites).

Patient data: Medical records held by the NHS such as GP and hospital records.

Phenome/phenotyping: The phenome describes observable biochemical or physical characteristics of an organism, resulting from the interaction of its genes with the environment. Phenotyping is the process by which a person's phenome is measured.

Policy and practice: Health care or public health policies made by organisations in particular the NHS or central and local Government and the practical ways these polices are implemented.

Population cohort: A group of people deemed representative of a population who researchers study for a period of time, sometimes throughout life, to learn about health, development and what causes disease. Population cohorts where the participants are studied from birth are called birth cohorts.

Population data: Data from population cohort studies, or from other population-wide databases such as the UK census.

Population health/population-based research: The study of social and environmental influences on physical and mental health and well-being, with the aim of understanding how and why illness varies within and between populations.

Proof of concept: Establishing the feasibility of a treatment or preventative strategy.

Public health: Public health refers to the health of a population as a whole rather than that of an individual.

Regenerative medicine: an approach that aims to repair or replace damaged or diseased human cells or tissues to restore normal function.

Reprogramming: Converting a cell from one type into another.

Research governance: The guidelines, regulations, principles and standards that exist to ensure that research is safe, ethical and of a high quality.

Social science: The study of society and how individuals within a society interact.

Stem cell: A cell that can divide indefinitely to produce more stem cells, or develop into a variety of cell types. There are two types of stem cell: adult stem cells and embryonic stem cells.

Stem cell line: A group of identical, continuously dividing stem cells that all originate from a single cell, which can be grown or frozen without any change in characteristics. This means stem cell lines provide a consistent source of stem cells for research or clinical development.

Stratified medicine: Using diagnostic techniques to better identify subgroups of patients diagnosed with the same disease so that treatments can be more effectively developed and targeted. Sometimes referred to as 'precision' or 'targeted' medicine.

Synthetic biology: Engineering biological systems or synthesising biological components using sophisticated techniques. This can offer new approaches to understand mechanisms of health and disease, and the development of new classes of therapeutics.

Systems biology: The study of biological systems such as cells, organs or entire bodies by looking at them as a whole rather than taking them apart and focusing on their components. Systems biology seeks to understand the interactions between these components (often by using mathematics and computation) to understand how they work the way they do, and to make predictions about them.

Translational research: Research that speeds up the process of turning fundamental discoveries into improvements in human health or wealth.

Achieving our strategic aims and objectives

We will measure progress against our aims and objectives over the life course of this Strategic Plan.

KEY SUCCESS INDICATORS WILL BE:

STRATEGIC AIM ONE **Picking research that delivers**	Setting research priorities which are most likely to deliver improved health outcomes.	Demonstrable advancement of the national and international knowledge base in health and medical science, and positive economic impact generated. Pushing forward new frontiers in medical research through encouraging research proposals of the highest excellence. Funding profile aligned with research priorities.
STRATEGIC AIM TWO **Research to people**	Bringing the benefits of excellent research to all sections of society.	Measurable impact on the development of new policy and practice in the health research domain. New products, policies and procedures leading to improved prevention, diagnosis and treatment of disease, improved business processes and cost efficiencies. Creation and growth of new businesses as a route to commercialise the knowledge generated from medical research. Increased involvement of community sectors in health research debates and discussion.
STRATEGIC AIM THREE **Going global**	Accelerating progress in international health research.	Participation in global health research policy-making and implementation. A leading role in defining the agenda for support of the science base in the UK and Europe. Playing a key role in the implementation and evaluation of major research programmes in resource-poor settings.
STRATEGIC AIM FOUR **Supporting scientists**	Sustaining a robust and flourishing environment for world-class medical research.	Evidence that MRC funding has helped to attract and train the skilled people needed for research and the wider UK economy. Major infrastructure projects completed on time and to budget and administrative efficiencies delivered to maximise front-line science funding. New technologies, methods and tools benefiting medical research and development and wider economic growth. Recognition of the UK as being the preferred location for investment by the healthcare industry.

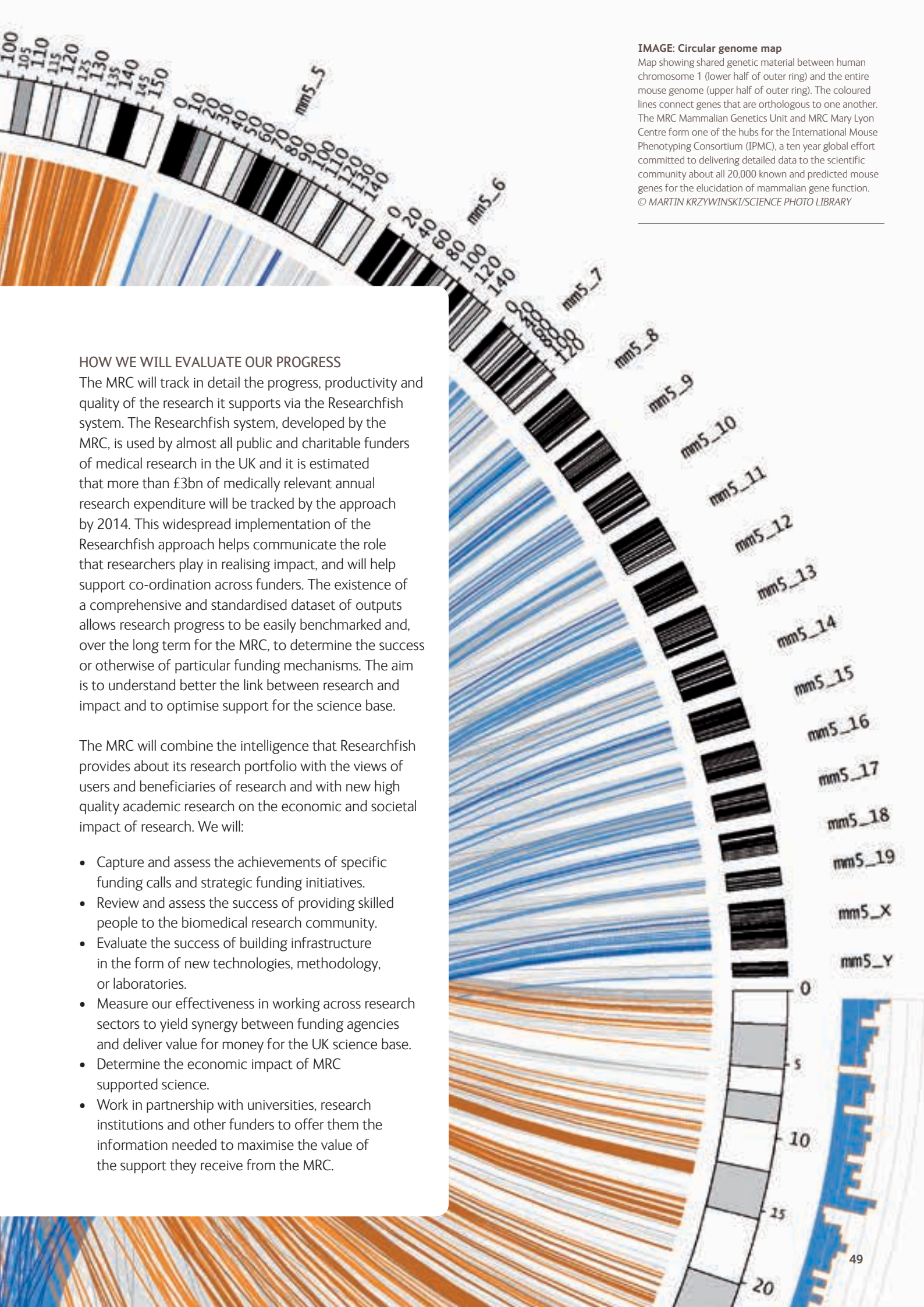


IMAGE: Circular genome map
Map showing shared genetic material between human chromosome 1 (lower half of outer ring) and the entire mouse genome (upper half of outer ring). The coloured lines connect genes that are orthologous to one another. The MRC Mammalian Genetics Unit and MRC Mary Lyon Centre form one of the hubs for the International Mouse Phenotyping Consortium (IPMC), a ten year global effort committed to delivering detailed data to the scientific community about all 20,000 known and predicted mouse genes for the elucidation of mammalian gene function.
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HOW WE WILL EVALUATE OUR PROGRESS

The MRC will track in detail the progress, productivity and quality of the research it supports via the Researchfish system. The Researchfish system, developed by the MRC, is used by almost all public and charitable funders of medical research in the UK and it is estimated that more than £3bn of medically relevant annual research expenditure will be tracked by the approach by 2014. This widespread implementation of the Researchfish approach helps communicate the role that researchers play in realising impact, and will help support co-ordination across funders. The existence of a comprehensive and standardised dataset of outputs allows research progress to be easily benchmarked and, over the long term for the MRC, to determine the success or otherwise of particular funding mechanisms. The aim is to understand better the link between research and impact and to optimise support for the science base.

The MRC will combine the intelligence that Researchfish provides about its research portfolio with the views of users and beneficiaries of research and with new high quality academic research on the economic and societal impact of research. We will:

- Capture and assess the achievements of specific funding calls and strategic funding initiatives.
- Review and assess the success of providing skilled people to the biomedical research community.
- Evaluate the success of building infrastructure in the form of new technologies, methodology, or laboratories.
- Measure our effectiveness in working across research sectors to yield synergy between funding agencies and deliver value for money for the UK science base.
- Determine the economic impact of MRC supported science.
- Work in partnership with universities, research institutions and other funders to offer them the information needed to maximise the value of the support they receive from the MRC.

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