Institution: Imperial College London

Unit of Assessment: 01 Clinical Medicine

a. Context:

Since our foundation in 1907, the College has had the application of our work to industry, commerce and healthcare as central to our mission. Here we describe how the College has enabled this mission to be addressed in Clinical Medicine across our 7 vibrant research groups and exemplified by the 34 impact case studies submitted. We also will outline our supporting plans to provide an enabling environment to enhance our current impact and to produce greater impact in coming years.

The impacts of our clinical research at Imperial College extend from fundamental biological discovery through clinical research at all phases and the pharmaceutical industry, to the application of research at a population level and in health policy. The impact of all our research groups (denoted in brackets) has grown out of our very strong engagement with key beneficiaries:

i) With healthcare for impact on patient health and welfare, through:

- Development of innovative diagnostics, e.g. use of microbubbles to differentiate benign and malignant tissue (Cancer); use of exhaled nitric oxide as a non-invasive biomarker of lung inflammation (Respiratory)
- Development of medical and surgical devices, e.g. radiofrequency assisted liver resection and robotics for joint reconstruction (Surgery and Surgical Technology)
- Development of new chemical entities, e.g. anti-tumour necrosis factor (α-TNF; Infection, Immunology and Inflammation); temozolomide (Cancer)

ii) With the National Health Service, and international healthcare providers for an impact on capacity, cost and value of services delivered, through

- creation of clinical guidelines, e.g. outcomes from the ASCOT trial (Cardiovascular) providing the international benchmark for management of hypertension and the SPARTAC trial in primary HIV infection (Infection, Immunology and Inflammation)
- strategies for improved service provision and treatment, e.g. improving outcome for gestational trophoblastic disease (Cancer); switching strategy for the treatment of breast cancer (Cancer)
- improving the safety and quality of healthcare; World Health Organisation (WHO) Checklist and applications of routine clinical data (Surgery and Surgical Technology)

iii) With business for an impact on commerce, and development of a knowledge-based economy

- sale of successful spinouts to international pharmaceutical companies, e.g. Thiakis (Diabetes, Endocrinology and Metabolism), Circassia (Respiratory)
- generation of successful spin out companies, e.g. PolyTherics (Infection, Immunology and Inflammation) and Respivert (Respiratory)
- Working with industry to develop new products, e.g. tiotropium bromide for the treatment of asthma/COPD (Respiratory)

iv) With government, regulatory and professional societies for an impact on policy

- development of international standards, e.g. development of a framework to assess the toxicity of drugs and chemicals (Computational and Systems medicine)
- introduction of healthcare policy, e.g. mass screening programme for colorectal cancer (Cancer)
- influencing independent regulators, e.g. prevention of occupational asthma (Respiratory)

v) Public and patient engagement activities cut across all fours areas, as detailed below.

It is these five areas which have shaped our approach to impact to date and are central to our plans during the next REF period.

b. Approach to impact

At the heart of our long-standing approach to impact is a commitment to delivering novel or enhanced diagnostics, therapies and medical devices and evaluating their efficacy and impact for reducing ill health for patients and populations. This focus underpins and continually informs our deployment of a range of coordinated mechanisms for engagement with all our beneficiaries to

deliver improvements in health and life-quality for recipients of care.

Framework for Creating Impact on Healthcare Providers

The cornerstone of our capacity for delivering health, economic and commercial impact is a strong and synergistic relationship with the health service and health service agencies. At a local level, we have created a portfolio of complementary, externally awarded partnerships which facilitate engagement with healthcare practitioners and managers, and service users. These are:

Academic Health Science Centre (AHSC): The pull through of innovations into applied patient benefit is supported and enhanced by our partnership with Imperial College Healthcare NHS Trust (ICHNT), the Imperial AHSC. Designated by the Department of Health in 2009, the stated purpose of the Imperial AHSC is to utilise excellence in research and education to transform health outcomes and to support the UK's globally competitive position in healthcare related industries by increasing societal and economic gain. The AHSC is underpinned by a Joint Working Agreement (JWA), which provides a formal framework for management and governance, and importantly, for agreement of intellectual property (IP) rights between the partners, through Imperial Innovations. Clinical input into broad programmatic strategies to maximise the potential for health, economic and commercial impact from our research is managed through the joint AHSC Research Committee comprising academics, consultants and NHS managers.

The power of our AHSC to align strategy, organisation and capital to create new infrastructure to realise the health, economic and commercial benefits of our discovery research is demonstrated in our flagship Imperial Centre for Translational and Experimental Medicine (ICTEM) at Hammersmith campus. Opened by the Chancellor of the Exchequer in 2012 this c£70M facility houses research labs and the NIHR/Wellcome Trust Clinical Research Facility (CRF; 2012-7; £10.9M) which enables the early evaluation of novel interventions in humans. We have relocated cancer molecular target discovery to ICTEM, aligned to expansion of phase I cancer trials capacity in the CRF. We have also relocated all of discovery cardiovascular sciences in parallel to relocation of tertiary clinical cardiology to Hammersmith Hospital. The Medical Research Council (MRC) Clinical Sciences Centre (CSC) has expanded into ICTEM with relocation of cardiovascular and genomics groups; this has allowed alignment of all our cardiovascular and cancer biology together with the MRC CSC, and adjacent to the CRF, under a single roof and fully aligned to service reconfiguration. Furthermore, this facility positions all aspects of discovery science from model organisms to technology platforms and imaging in an environment directly contiguous with translation through to patient care. Further exemplars of AHSC alignment to maximise clinical academic interface, to the benefit of the patient include: alignment between the Centre for Infection Prevention and Management and ICHNT has led to successful infection control policies at ICHNT; the Surgical Innovation Centre designed for high turnover minimally invasive surgery co-located with the College's Clinical Skills Laboratory for under-and postgraduate teaching, and the Robotic Assisted Microsurgery Laboratory - a prime example of synergistic activity for direct patient benefit and exemplified by the impact of Darzi and colleagues in developing a safer surgical workforce (case study).

NIHR Biomedical Research Centre (BRC) and Units (BRUs): The engine-house of our clinical translation to health and economic benefits is our associated NIHR infrastructure, the largest example of which is our NIHR Imperial BRC, first established with ICHNT in 2007, current award £113M [2012-2017]) The NIHR Imperial BRC provides a core infrastructural resource and also seeds clinical innovation programmes to facilitate health and economic gains from our 19 translational research themes. All themes receive specific project funding to support interactions between research groups and clinical units (for example, i-Knife, a surgical diathermy knife which can accurately identify cancerous tissue and differentiate it from normal tissue during a procedure through analysis of the diathermy smoke plume via real-time mass spectroscopy) to develop proposals as a first step in enabling impact from our science base. Theme programmes explicitly include and monitor action plans for engagement with key impact audiences such as industry and public/patients. Further core funding is made available for strategic initiatives to support impact at a staff level (see below.) Mile-stoned programme management and detailed annual reporting of activity in each theme enables us to track and evaluate potential clinical impact arising from our science (for example, the Spartac trial of therapy at primary HIV infection). Alongside our NIHR BRC and AHSC partnership with ICHNT, the College also acts as academic partner with the Royal Brompton and Harefield NHS Foundation Trust, for both the NIHR Respiratory BRU (£10.5M

[2012-2017]) and Cardiovascular BRU (£10.5M [2012-2017). Furthermore the Imperial NIHR BRC and BRUs through co-funding of translational science provide the environment to facilitate health and welfare impact arising from our physical and life sciences scientists and engineering colleagues in UoAs 8, 9, 11 and 15. UK Clinical Research Collaboration (CRC) fully-registered Imperial Clinical Trials Unit (ICTU) provides support and services for study design, monitoring and management across all trial phases. We have enhanced ICTU's capacity to support activity across the region further; the number of clinical trials through ICTU has increased from 2 to 62 over the period 2008-2013, the outcomes of which will have future health and wealth impact.

Extending the Reach of Our Impact on Healthcare Beneficiaries: Beyond the borders of our AHSC and NIHR BRC/BRUs, we have acted during the period as an academic partner with local provider trusts in a number of interlinked networks including the Higher Innovation and Education Cluster (HIEC, 2009-2012), the NIHR Collaboration for Leadership in Applied Health Research and Care (CLAHRC, renewed 2013-8), and Health Education North West London (HENWL, 2013). The CLAHRC has facilitated dissemination of new therapeutic approaches, for example the design and implementation of effective new methodologies for coordinated service delivery in novel care bundles for COPD and the use of tele-monitoring in congestive cardiac failure, which we anticipate will be future impact case studies.

Since 2012, the AHSC has been nested within Imperial College Health Partners (ICHP; Darzi [Chair]); a limited company established between the College and 10 local acute, mental health and community NHS trusts. The ICHP, which seeks to complement and build on the significant achievements of the above networks during the period, through dissemination and late stage translation has been designated by NHS England as an Academic Health Science Network (AHSN, May 2013): The AHSC Director of Research (Weber [UoA2]) chairs the AHSN research committee and there is aligned strategic vision for the continuum of research from discovery to impact (underpinning expertise within our Institute of Global Health Innovation, Imperial College Business School [UoA19], School of Public Health and ICTU), with an AHSC focus on early stage translation and AHSN on translation, dissemination and uptake. For example, the AHSN is facilitating the uptake of MYACTION, an integrated primary and secondary care vascular prevention programme (Case Study).

The three London AHSCs plus Oxford and Cambridge formed the Global Medical Excellence Cluster (GMEC) in 2008, in order to jointly collaborate with the pharmaceutical industry, to promote wealth generation across the five HEIs and their associated hospitals and to facilitate cooperation in presenting healthcare research and delivery externally. GMEC was instrumental in developing the relationships and legal framework for the creation of Imanova, a pan-London imaging facility at the Hammersmith Hospital campus, and company jointly owned by the three HEIs and MRC, to generate new PET ligands, to support first-in-man clinical studies and drug development in the pharmaceutical industry. GMEC is currently concluding a plan for collaboration with Pfizer for rare disease access and in-depth phenotyping across the cluster.

Impact on Commerce and the Development of a Knowledge-based Economy

Intellectual Property and Commercialisation: The College, through Imperial Innovations plc supports academic staff to create, build and invest in pioneering technologies, combining the activities of technology transfer, company incubation and investment. Since 2005 Imperial Innovations has raised £206M in proceeds from investors. Its business model comprises an integrated approach across the whole commercialisation process and remains an exemplar for other institutions both in the UK and abroad. In the 2011-12 financial year Imperial Innovations invested £37.9M in 29 companies, appraised 377 inventions and filed 51 patents. Investigators within the UoA have utilised Imperial Innovations to build successful partnership and technology transfer activity across the breadth of our portfolio, for example Thiakis, Respivert and Circassisa (all case studies in this return). Currently, 6 spin-out companies from UoA1 are located within our bio-incubator facilities at South Kensington, e.g. Kesios Therapeutics, which will have future REF impact. Imperial Innovations also provide drop in sessions for academics at all stages of their careers to discuss tentative ideas for exploitation with nominated contacts as well as structured departmental briefings on issues such as IP management and start-up formation.

We seed activity in this area through the NIHR Imperial BRC/Innovations Fund which comprises academic researchers, Innovations staff and drug, devices and diagnostics development experts. The group runs a primer fund competition and in 2012 funded 5 therapeutic drug discovery 'primer'

projects. The potential for commercialisation is critical in funding decisions. This successful initiative was re-launched as the Imperial Confidence in Concept (ICiC) scheme for 2013/14, this time enhanced with an additional award of £700,000 from the MRC, aligned funding from our Wellcome Trust Institutional Strategic Support Fund (ISSF) and matched Higher Education Innovation Fund and College support. ICiC currently supports 19 projects (£1.3M) of which a high proportion will form future impact cases.

Engagement and Collaboration with Industry: Our successful partnership and knowledge transfer with industry is pivotal in realising effective development and distribution of many of our discoveries, and in maximising commercial impact both in the UK and internationally.

Imperial Consultants is the UK's leading academic consultancy provider, with a turnover of £16.5M (2010-11). It enables staff to capitalise on their specialised knowledge and expertise by undertaking external consultancy work to benefit society and the economy, see http://www.imperial-consultants.co.uk/expertise/clinical-medicine). We encourage participation in these activities as an important route to ensuring the knowledge derived from our research activities can be widely and diversely employed. In 2011-2012 we undertook 487 consulting projects for 251 distinct commercial clients.

Our Unit approach to engagement with industry seeks to broker (through corporate level interaction, strategic co-investment, and person-to-person engagement) a fertile blend of collaboration. We recognise that the complexity of potential collaborative opportunities can require specialist relationship management to ensure the needs of both sides are addressed. To this end a Corporate Partnerships Manager has been embedded within the Faculty of Medicine since 2009, working with our Research Strategy group, Innovations and across the College, with a core focus on identifying, facilitating and managing the development of relationships between individual PIs and industry partners leading to strategic alliances. Recent examples include Johnson & Johnson Proof-of-concept Initiative, AstraZeneca External Discovery Partnerships Initiative to deliver joint high throughput screening projects in 2013 and the Pfizer, £2.3M respiratory collaboration, and our major alliances with MedTech/equipment manufacturers, Waters and Bruker to support programme development, training, and knowledge transfer programmes. Faculty level draws on the expertise of Imperial Innovations and of key Faculty staff who have significant industry experience (Solari, Hill, Westwick) to better understand the commercial potential of our activity, and to develop proactive proposals to industry in which Imperial expertise matches Industry strategic intent. Our Joint Research Office provides advice and assistance with contract negotiation and the financial management of a project through its lifetime to reconciliation and closure of the grant.

Specific industry collaboration objectives are embedded within all NIHR Imperial BRC theme delivery plans. In 2012/13 the NIHR Imperial BRC supported 115 new strategic industrial collaborations, to the value of £15.3m. Our portfolio is further augmented by synergistic, devolved funding streams to enhance impact and facilitate multidisciplinary working provided by the EPSRC Impact Acceleration Account, BBSRC Sparking Impact Account and Wellcome Trust Institutional Strategic Support Fund (ISSF). The ISSF supports inward and outward sabbaticals (available to all levels of researchers) to support knowledge transfer with Industry. The excellence of projects emerging from our schemes has led to considerable interest and engagement from industry (MoU signed with AstraZeneca for access to all Imperial CiC proposals). Taken together, the funds provide an effective vehicle for regular interrogation (with appropriate external stakeholder input) of our rapidly evolving research base, mining our activity for potential areas of commercial development and supporting early stage translational studies. The process also assists us in identifying researchers who have appropriate interests and skill-sets to generate further industry partnering opportunities.

Our approach to increasing engagement with industry also involves supporting rapid trial initiation and delivery of studies to time and target. We have developed a new database system and workflows in support of this: the number of new commercially-sponsored clinical studies opening for recruitment has increased from 40 in 2008/09 to 78 in 2012/13. Since 2008/09, a total of 313 new commercial studies have been initiated. For example, our Hepatology Clinical Research Facility is conducting more than 50 studies with Roche, Gilead, Novartis, Bristol Myers Squibb, Janssen Cilag/Tibotec and Abbott; the theme has successfully increased recruitment of patients into protocols; >70% of patients attending are successfully enrolled into research protocols.

Testament to the strength of our ability to partner with industry to undertake relevant research is the College's high proportion of biomedical and health sciences publication outputs co-authored with one or more industrial partners (9.5% for 2008-2011 – the highest in UK of all institutions with >5000 Web of Science indexed publications) [CWTS Leiden Ranking 2013].

Impact on Public Policy

Policy, Regulatory and Professional Influence: We see the development and implementation of health care and regulatory policy as integral to our mission. We recognise that it is through this engagement our most successful research programmes will move into broader implementation.

Through the Imperial AHSN, in discussion with National Institute for Health and Care Excellence (NICE), we have agreed to a number of ways to work jointly facilitated through a dedicated NICE liaison person working with the AHSN core team on areas including: measuring the uptake of NICE guidance among partner organisation; developing measures of the current standards of care across partner organisations that provide a methodology for NICE and establishes a baseline for the AHSN; field testing new proposed NICE guidance to understand implementing best practice; providing a challenge function to NICE for new guidance or policy.

At an International Health level, the Imperial Institute for Global Health Innovation (IGHI) is a cross-Faculty research Institute supporting the College's strategy to find solutions to global challenges by focussing multidisciplinary research expertise on key international issues. The Centre for Health Policy (Donaldson, Smith [UoA15]), a joint venture between Imperial's Faculty of Medicine and Business School within IGHI, assists governments, clinical leaders and other decision-makers around the world to meet the strategic challenges of improving the health and wellbeing of their citizens and bridges the gap between researchers and policy-makers by undertaking both academic research and applied policy analysis, using multi-disciplinary project teams, and training the next generation of international health policy-makers. The IGHI runs an annual symposium on healthcare policy, the Global Health Policy Summit, where academics, politicians, healthcare administrators and international public health experts meet to determine key agenda items such as technologies for global health (Lancet 2012).

We actively encourage participation on beneficiary boards, committees and panels to help shape policies, regulations and professional guidelines. At a National level, Darzi was Minister of Health, 2007-2009, responsible for the far-reaching 2008 NHS review "High Quality Care for All" which led to a major shift towards the quality of care, and introduced the Quality Accounts reporting. Prof Lord Winston has remained active in promoting the mission of the AHSC in the Lords. Aitman acted as the scientific advisor to the House of Lords 2009 Report on Genomic Medicine. We have contributed to National and International policy through membership of key committees: Medicines and Healthcare Products Regulatory Authority (MHRA) panels (e.g. Boobis, Gooderham, Wilkins), NICE panels (e.g. Regan, Ghaem-Maghami, Cowie, Kroll), Openshaw on SAGE advising on pandemic Influenza, Donnelly advising the Ministry of Agriculture, Fisheries and Food on badger culling, Donaldson as Chairman of the WHO Independent Monitoring for the Polio Eradication Programme and envoy for patient safety. We produce primary data to inform decision making and contribute to the evidence base for policies in areas such as patient safety, through the NIHR Centre for Patient Safety and Service Quality (CPSSQ) and Dr Foster Intelligence. The CPSSQ, renewed after national competition in 2012, has played a leading role on implementation and evaluation of the WHO surgical checklist, hospital acquired infection, and outbreak analysis.

Patient and Public Engagement (PPE) and Involvement (PPI): Underpinning all of the above activity is a commitment to maximise the benefit of our work for our primary stakeholder: the patient. We actively encourage engagement and dissemination of our research to patients and the general public with the aim of increasing awareness and generating public debate. In doing so, we work closely with the College's and local Healthcare Trust Communications team, make use of multiple media channels, and make devolved funding available to support engagement activities. Service users and the public at large are kept informed of research work and encouraged to become involved through a number of channels that include:

- Patient representation on Planning Boards and Management Steering Committees, e.g. British Liver Trust participation in the Trial Management Group of the STOPAH trial; working with Vasculitis UK to facilitate the development of a Takayasu arteritis patient database through their "Route Map for Vasculitis;"

- Patient Information Leaflets: e.g. patients donating tissue for research are provided with a leaflet outlining the research process;
- Dedicated websites, e.g. www.imperial.ac.uk/tissuebank, www.police-health.org.uk (AIRWAVE study), www.cherub.uk.net, http://imperialbrc.org, and DVDs for global health studies e.g. the HIV intervention trials, Spartac, PopART, DART (sent to media outlets in the developing world);
- Public Presentations and Workshops, e.g. the annual NIHR BRC Research Festival aimed at patients, their relatives and carers, where all the BRC themes give interactive demonstrations of their research. All of the UoA1 themes also present their research at the annual Imperial Festival and Fringe events; in Easter 2013, 10,000 members of the public attended the Festival and engaged with the hands-on demonstrations, lectures, debates and performances;
- Bespoke engagement programmes within each of our externally funded centres of excellence, e.g MRC CSC science-arts and science for schools programmes, Imperial Cancer Research UK (CRUK) Centre Local Engagement and Development Programme;
- External Media: e.g. Taylor-Robinson has supported the production of a BBC documentary on liver disease; the CRUK Centre has commissioned a set of videos which explain the importance of clinical trials to be launched in 2013.

PPE and PPI programmes are mandatory across our NIHR BRC themes and are formally tracked and reviewed. To underpin, develop and monitor our effectiveness in achieving this commitment we have developed a programme of core and bespoke PPE and PPI activity, which supports UoA researchers in determining the priorities and best delivery mechanisms of our clinical research portfolio, and communicating key messages to our patient populations. NIHR BRC funding has been utilised to establish the Imperial Patient Experience Research Centre (PERC). The Centre draws together applied social and behavioural scientists from across the College and externally to provide researcher advice, support and training, and to undertake research investigations into the mechanisms required to achieve higher-quality PPI/E. The work of PERC complements theme specific activity, for example: enabling participation in review of applications (the centre collaborates with ICTU to ensure investigators are aware of this support in development of trials); creation of Patient and Public Groups to contribute to key research design and delivery areas including refinement of proposals and, protocols (e.g. Infection - ongoing qualitative study with migrant health screening for tuberculosis, HIV and hepatitis B/C) and input into patient information sheets and grant and ethics applications (e.g. Aneurysm Screening Trial), on-going project management (Cancer); patient and carer contribution to reporting and dissemination (e.g. promoting the Brain Bank programme in Parkinson's and Multiple Sclerosis).

Within our NIHR Wellcome Trust Imperial CRF, a PPI/E Manager is building on our network of patient associations to enable patients to comment and contribute to research plans and proposals through their experience and needs (working closely with PERC). Feedback from research participants is captured in patient forums and anonymously through I-Track, a real-time feedback system linked to desktop reporting. An example of this approach delivering real impact on and through our clinical research agenda is the 'Qutenza' study – a trial initiated in response to patient feedback on pain at the site of subcutaneous infusion of a prostanoid (Treprostinil) for pulmonary hypertension.

In the North West London region, we have worked as part of the CLAHRC to enhance and embed PPI/E strategies, engaging with patients in many ways: creation of patient CLAHRC NWL fellows; delivery of training to members of the public engaging in PPI/E through the Effective Patient and Community Representative Programme; operation of Patient Led projects such as Diabetes Improvement through Mentoring and Peer Led Education. Produced in collaboration with our NIHR infrastructure partners at across North West London, we have produced a film which documents the experiences of our patient volunteers that have partaken in the research process.

A further key contributor to ensuring effective, safe delivery of care is our NIHR Centre for Patient Safety and Service Quality discussed above.

Imperial College runs specific outreach schemes such as the 'Reach Further Programme' in the Wohl Reach Out Lab, director Prof Lord Robert Winston, this initiative targets secondary schools and over 20,000 visits have been made since the labs opened in 2010. We utilise Wellcome Trust ISSF funding to expand the 'reach' of the Reach Out programmes to further schools in North West London. In addition Wellcome Trust ISSF funding supported the PE Tricycle which has won a gold medal in the prestigious Internal Council for Advancement and Support of Education Circle of Excellence awards.

Our approach to supporting UoA1 staff to realise the impact of their research is multi-faceted, reflecting the breadth and complexity of our stakeholder groups and range of potential impacts. We have invested in resources, programmes, and networks to:

- Remove unnecessary barriers to and provide target resource for rapid transfer from discovery to implementation, e.g. through the establishment of the NIHR Imperial BRC, JRO and bespoke, devolved funding streams;
- Support our researchers to identify and cultivate impact from their discoveries, e.g. through Imperial Innovations and Imperial Consultants;
- Enable researchers to reach out to users to continually improve our understanding of, and respond to, their needs, e.g. through the CLAHRC and PERC;
- Promote contributions to wider debates on health and wealth improvement to transfer our expertise and influence policy and practice, e.g. though the Institute for Global Health and Innovation and London Life Sciences (pan-London AHSCs).

c. Strategy and plans:

The impact of our research groups has grown out of engagement with key beneficiaries in 5 core areas, as summarised in section a. During the next REF period we will implement and monitor the following plans to ensuring the successful delivery of the College's mission to apply our endeavours to these key beneficiaries:

i) With healthcare for impact on patient health and welfare, through the translation of our research to implementation by health service practitioners. We will:

- Promote our pipeline of devices, diagnostics and new chemical entities. We will align elements of our devolved funding streams from MRC (Confidence in Concept), EPSRC (Impact Acceleration Award) and Wellcome Trust (ISSF) to create the Imperial Joint Translation Fund, a £5M annual pump priming fund.
- Renew our AHSC, NIHR Imperial BRC and BRUs, CLAHRC and AHSN funding during the next REF period to maintain our close partnership with healthcare providers to facilitate early translation of our discovery research through to dissemination and uptake.
- Co-locate administration of the AHSC, AHSN, CLARHC, HENWL and LCRN to a single office to allow alignment of research strategy across these funding streams at Imperial West.
- Work closely with Cerner Millenium and the NIHR BRCs at Oxford, Cambridge, UCL and Kings to improve research data warehousing and create a large scale automated data collection platform to extend the reach of potential healthcare impact initially in the areas of viral hepatitis, critical care medicine, transplantation, acute coronary syndrome and ovarian cancer.
- Expand the reach of our impact on healthcare beneficiaries through our new Lee Kong Chian Medical School (LKC), a partnership between Imperial and Nanyang Technological University, Singapore. The LKC opened for new students in August 2013 with an entirely new medical curriculum and jointly appointed academic staff. A research concordat between Imperial College and NTU has been signed, and funding to pump-prime joint research programmes in the UoA1 themes of Metabolic Medicine, Infection and Computational Medicine and phenotyping will commence in 2014. We aim that these programmes will form the basis of impact case studies in 10 to 15 years.
- Expand other global developments such as the Diabetes Centre in Abu Dhabi and the Qatar Biobank. We shall capitalise on these new structures to reach out to new populations and address/delivery bespoke solutions for different populations to improve treatment strategies. Working through the Wellcome Trust Global Health Research Centre, we shall continue to develop health solutions for African countries.

ii) With the National Health Service, and international healthcare providers for an impact on capacity, cost and value of services delivered. We will:

- Expand our health services research in conjunction with Imperial College Health Partners and Imperial Business School to evaluate the cost and value of our impact on health care providers.
- Co-host through our partnership with ICHNT, the NIHR Local Clinical Research Network (LCRN - 2014-2019 £75M). The LCRN will enable pump-priming of innovation and dissemination strategies through the AHSN in a manner similar to that of the BRC support to

the AHSC.

iii) With business for an impact on commerce, and development of a knowledge-based economy. We will:

- Capitalise on new opportunities at the Imperial West development in West London, adjacent to the Hammersmith Hospital Campus, to build our BioMedical Translation Institute, bringing Imperial Engineering and Physical Sciences alongside clinical medicine.
- Build new bio-incubator space at Imperial West for future spin out companies and collocate with industry to promote the knowledge-based economy.
- Encourage further industry/academic knowledge exchange through increasing secondments (via Wellcome Trust ISSF support) and strategic alliances (e.g. planned knowledge exchange programme with GSK at Professorial level).
- Renew our Wellcome Trust/GSK clinical PhD training programme in clinical pharmacology
- Enhance our training programmes in conjunction with Imperial Innovations regarding exploitation, intellectual property management and start-up formation.
- Exploit the Joint Innovation Fund. Imperial Innovations, in collaboration with the Technology Transfer Offices at UCL, Oxford and Cambridge, have recently announced a £40M Joint Innovation Fund supported by the European Investment Bank in order to support University spin-out companies and also support the commercialisation of research opportunities in partnership with industry, retaining University ownership and reducing risk (spin-in).
- Be a key partner with UCL and King's AHSC, in the London Life Sciences Group (LLS), together with the Greater London Authority (GLA); LLS jointly supports Improvement Science London which acts as an umbrella organisation to promote and implement health improvement studies across London. In 2013, the GLA announced a £1.3M investment in MedCity, to promote the use of London's healthcare and health research to promote wealth and create jobs through renewed inward investment.

iv) With government, regulatory and professional societies for an impact on policy. We will:

- Expand role of the Institute of Global Health Innovation in advising governments and business on health policy through strategic collaborations with external organisations in the UK and abroad.
- Continue to conceive and implement annual Global Health Summit. The World Innovation Summit for Health (WISH) is the successor to last year's Global Health Policy summit and will be held on December 2013 in Doha.

v) Public and patient engagement activities cut across all fours areas. We will:

- Work with Imperial College Health Partners to align PPI and PPE activities of the AHSC, AHSN, CLARHC, and LCRN, across tertiary to primary care settings.
- Extend this aligned programme to local communities as part of the Imperial West development.
- Enhancing training programmes to ensure PPI and PPE impact and expand the cadre of engagement expertise, building on Wellcome Trust's first Engagement Fellowship, awarded to Professor Kneebone.
- Work with our closely aligned charities, such as the Genesis Trust, Ovarian Cancer Trust, Jefferiss Trust and our partner hospital charities (e.g. Imperial College Healthcare Charity, NHLI Foundation) on scientific strategy and fund-raising.

We will monitor the progress of these activities in relation to supporting, enabling and achieving impact through the College and AHSC Research Committees. Through the College Research Strategy office, the College has invested in Impact Officers to track the potential impact of research endeavours.

d. Relationship to case studies:

As noted in section b, at the heart of our long-standing approach to impact is a commitment to reducing ill health for patients and populations, through a range of coordinated mechanisms. These mechanisms may impact on more than one type of beneficiary. By way of exemplifying our approach to impact, we have defined the *major* relationship between each of the 34 impact cases

studies submitted and mechanism deployed:

Creating Impact on Healthcare Providers

Imperial clinical researchers have designed, led and reported a number of definitive clinical trials and clinical research programmes over the REF period which have formed or changed treatment guidelines for large numbers of patients in both common and rare diseases nationally and internationally. Notable examples include demonstrating the beneficial use of statins to prevent cardiovascular events in patients with hypertension; showing the clinical value of antiretroviral therapy at primary HIV infection; improving outcomes of patients with rapidly progressive glomerulonephritis; defining management guidelines for HIV-1 tuberculosis immune reconstitution inflammatory syndrome 'IRIS'; revising the management of pulmonary arterial hypertension; development of a cardiac magnetic resonance technique to identify of thalassaemia major patients at risk of heart failure; demonstrating the effectiveness of subcutaneous allergen immunotherapy in hayfever sufferers; showing the beneficial use of beta-blockers for chronic heart failure; improving outcomes of patients with Duchenne muscular dystrophy; introducing an effective switching strategy for the treatment of breast cancer; improving the management of patients with abdominal aortic aneurysms; introducing treatment guidelines for HIV associated Multicentric Castleman's Disease; and improving the management of tuberculosis in children

We have developed new and innovative diagnostics, for example, microbubbles to differentiate benign and malignant tissue; nitric oxide as a non-invasive inflammation biomarker in asthma and diagnostics to stratify management and predict outcome in Chronic Myeloid Leukaemia

We have developed strategies for improved service provision, for example, providing evidence to support discontinuation of urethral smears in asymptomatic men with non-gonococcal urethritis; developing an integrated vascular prevention programme and improving outcome for gestational trophoblastic disease.

We have revolutionised the treatment of rheumatoid arthritis through α-TNF and other inflammatory conditions. Imperial researchers have worked closely with patient groups, public and healthcare policy makers to ensure that the outcomes of these clinical trials are fully known and understood.

Impact on Commerce and the Development of a Knowledge-based Economy

Intellectual Property and Commercialisation: Imperial has a highly entrepreneurial culture and with Imperial Innovations, a large number of spin-out companies have been created over the REF period. Within this submission, we have included examples of spin out companies developing novel conjugation technologies (PolyTherics), immunotherapeutics (Circassia), devices for radiofrequency assisted liver resection (EMcision), and robotics for joint reconstruction (Acrobot).

Engagement and Collaboration with Industry: We have had longstanding research collaborations with GSK, and jointly developed the long-acting anti-cholinergic drug Tiotropium bromide for the treatment of asthma/COPD. Imperial has also worked closely with Pharma in the development and then implementation of drugs within clinical niches. For example, we have developed the anti-cancer drug Temozolamide for the treatment of malignant glioma; Temozolamide is now used globally as first indication for this tumour. Furthermore, during the REF period we have sold spinouts to international pharmaceutical companies such as Thiakis which has developed analogues of oxyntomodulin, and Respivert which has developed potent inhaled inhibitors of PI3Kδ for the management of chronic obstructive pulmonary disease.

Policy, Regulatory and Professional Influence

We have influenced health policy through developing a feasible, acceptable and cost-effective screening programme for colorectal cancer and developed a set of WHO Surgical Checklists in order to standardise and reduce operative morbidity and mortality through the adoption of simple but standard procedures prior to the operation.

We have influenced regulatory bodies for example the development of a framework to assess the toxicity of drugs and chemicals, and the demonstration that the risk of occupational asthma is related directly to the level of exposure in the workplace.

We have had professional influence through shaping guidelines for surgical training curricula and continued professional development in the NHS.