Institution: Imperial College London

Unit of Assessment: 01 Clinical Medicine

a. Overview

Translation of our discovery science into clinical benefit is the cornerstone of our research strategy; since RAE2008 we have focussed on developing new research capacity on a substantially re-built and re-equipped Hammersmith Hospital campus and purchased the Imperial West site which will bring biomedical components of the Faculties of Engineering and Natural Sciences alongside Medicine. We have established a formally designated Academic Health Sciences Centre (AHSC), renewed our National Institute of Health Research (NIHR) Biomedical Research Centre (BRC) and Units (BRUs) and currently hold 29 externally-funded centres of excellence. Consequently 406 principal investigators are returned to UoA1 (90% of eligible staff).
The major research groupings under clinical medicine are as follows:

- Cancer medicine (41.60 FTE)
- Cardiovascular medicine (49.75 FTE)
- Computational and systems medicine (18.10 FTE)
- Diabetes, endocrinology and metabolism (32.33 FTE)
- Infection, Immunology and inflammation (96.65 FTE)
- Respiratory medicine (55 FTE)
- Surgery and surgical technology (40.75 FTE)

b. Research Strategy

Our research strategy is to make fundamental discoveries and translate these most efficiently into the clinic, to the benefit of our local patient population and globally, with substantial contribution to the health and wealth of the nation.

To achieve this strategy, we have invested in both our academics and their environment. The College has spent £325M on physical infrastructure since 2008, concentrating our previously distributed experimental medicine capacity from across West London onto purpose built facilities on our Hammersmith campus in a landmark £70M Imperial Centre for Translation and Experimental Medicine (ICTEM), physically contiguous with the Imanova imaging facility, the Medical Research Council (MRC) Clinical Sciences Centre (CSC) and the MRC/NIHR National Phenome Centre. The new Imperial West development on a 23 acre site adjacent to the Hammersmith will bring innovation in Engineering and Natural Sciences and big data alongside the clinical campus, underpinning our institutional commitment to facilitating translation. We have used our AHSC strategically to align research groups with service reconfiguration by campus.

Since the last RAE 2008, we have recruited 257 investigators of which 78 are Early Career Researchers in this UoA, all returned and underlined in this narrative. (Staff returned within other UoA submissions are not italicised.) The quality of our return is reflected in our 13 Wellcome Trust (WT) Investigators, our 6 MRC Centres awarded since 2008 among our 29 externally funded centres, our 224 publications with >100 citations each since 2008 (and 73 with > 200 citations), our 8 Fellows of the Royal Society and our 41 Fellows of the Academy of Medical Sciences.

The Faculty has continued a close working partnership with the MRC. The MRC CSC (£82.6M, 2011-16), which focuses on epigenetics, integrative biology and genes and metabolism, is embedded on the re-built Hammersmith campus. The MRC CSC provides high quality basic expertise in cellular and molecular biology, which underpins the research activity presented in this submission. The MRC CSC strengths in the development of model organisms (zebrafish [*Ingham*]; drosophila [*Miguel-Aliaga*], *C. elegans* [*Martinez-Perez, Brown*], yeast [*Aragon, Marguerat*]) enhance interpretation and expedite translational discovery based on human data and pathology. We have developed a clinical training fellowship programme to place clinical PhDs into non-clinical labs in the CSC, with joint clinical supervision, using a cohort approach with specific mentoring. This scheme, known as the Chain-Florey, has been enthusiastically embraced with 15 fellowships appointed to date. Furthermore, two Chain-Florey clinical lectureships have been established to progress the most successful fellows.

Since 2008, we have established or renewed six MRC Centres; these capabilities reside across all three medical UoAs at Imperial, and include the Centre for Environment and Health, funded by MRC and Public Health England (PHE) and the MRC Centre for Outbreak Analysis. The MRC Asthma UK Centre was renewed, the MRC Centre for the Developing Brain initiated (2012), the

MRC/NIHR National Phenome Centre launched (2013) and the MRC Centre for Molecular Bacteriology and Infection opened (2012); this operates across the Faculty of Medicine and the Faculty of Natural Sciences and has recruited extensively to become the largest centre of molecular bacteriology nationally, with four WT Investigators (*Holden*, Matthews [UoA6]), *Grundling*, *Wigneshweraraj*). Our investment in Cancer has been recognised by the award and renewal (2013) of a Cancer Research UK (CRUK) Centre and has further developed with the creation of a new Centre in Systems Oncology and Innovation as a joint venture with the Institute of Cancer Research (ICR).

The framework for our biomedical translation is provided by our integrated Academic Health Sciences Centre (AHSC), created in partnership with Imperial College Healthcare NHS Trust (ICHNT) in 2007 and formally designated by the Department of Health (DoH) in 2009. The AHSC is nested within the Imperial College Health Partners (ICHP; established 2010, *Darzi* [Chair]) incorporating 13 trusts in northwest London and 8 clinical commissioning groups, recently designated as an Academic Health Science Network (AHSN). The AHSN permits the integration of early and late stage translation in NW London and dissemination of the impacts of innovation across the patient population. ICHNT was recently awarded the Local Clinical Research Network (LCRN), a £75M award to build clinical research and trials activity throughout NW London.

The translational research engine of the AHSC is provided through the renewal of the NIHR Imperial BRC (£113M, 2012-2017, largest award nationally) with disease specific themes and technology platforms in genomics, stratified medicine, molecular phenotyping, biobanking and imaging. These themes are congruent with the research groupings returned across UoA1, 2 and 4. In partnership with the Royal Brompton Hospital (RBHNT), Imperial has an NIHR Respiratory BRU (£10.5M, 2012-2017) and a Cardiovascular BRU (£10.5M, 2012-2017) to conduct translational research in respiratory and cardiovascular disease.

Interdisciplinary translational research with colleagues in the physical sciences, engineering and business within the AHSC and AHSN is facilitated by the BRC and devolved funding streams. We have established an annual £5M Imperial Translation Fund, comprising the Imperial MRC Confidence in Concept Scheme, Engineering and Physical Sciences Research Council (EPSRC) Impact scheme, the WT Institutional Strategic Support Fund (ISSF) and Imperial Innovations in order to support early translation opportunities. Through this mechanism we have established a collaboration with AstraZeneca for novel targets to access high-throughput screening.

Significant changes to research environment

Since 2008 we have focussed our experimental medicine at the ICTEM. The top 4 floors of ICTEM focus on molecular target discovery sciences in the cardiovascular, metabolic, inflammation and cancer themes. The ground floor houses the WT/NIHR Imperial Clinical Research Facility (CRF; Director, *Wilkins*) which undertakes all the first-in-man and deep phenotyping studies across the AHSC and co-ordinates studies using advanced imaging (using PET-CT and PET-MRI) through the Imperial College Clinical Imaging Facility. We have established Imanova, a highly innovative alliance between the MRC, Imperial, Kings College London (KCL) and University College London (UCL) for imaging sciences and their application to drug and diagnostic development, focussing particularly on novel PET imaging. As examples of using the AHSC to deliver our integrated strategy, all tertiary cardiology has relocated to the Hammersmith Hospital, planned in parallel to the relocation of academic cardiovascular sciences from the South Kensington campus to ICTEM. Similar relocation of metabolic medicine, neuroscience and cancer research to the Hammersmith campus has also been achieved creating a powerful nucleus of translational research co-located with genetics, genomics, imaging and our unique metabonomics capability at the MRC/NIHR National Phenome Centre.

The Imperial Clinical Trials Unit (ICTU; Ashby, Poulter [Directors, UoA2]) was established in 2008 as a single entity through the merger of clinical trials expertise across the Faculty of Medicine, ICHNT and the RBHNT. ICTU was fully accredited by the NIHR CRN in 2012. All IMP studies across the AHSC are run through ICTU, with obligatory use of the INFORM database to ensure universal compliance with GCP. Strongly linked to ICTU is the WT Imperial Centre for Global Health Research (Director, *Levin*), with groups embedded in HEIs in South Africa (*Wilkinson*), Kenya/Uganda (Maitland [UoA2], *T Williams*), Gambia (*Kampmann*) and Peru (*Evans*).

The Institute for Global Health Innovation (IGHI; *Darzi* [Chairman]), established in 2010, hosts the Centre for Health Policy, which leads evidence-based research to influence and shape

healthcare policies; the Hamlyn Centre for Robotic Surgery (with Engineering), which leads the development of new imaging, sensing and robotics technologies; and HELIX, a collaboration with the Royal College of Arts bringing together science and design to create high-impact, low-cost solutions for healthcare need in both the developing and developed world. The Imperial Business School works closely with the Faculty of Medicine in health economics (Smith), health systems (Atun) and in public health (Barlow) all returned in UoA19.

Our research themes are:

Cancer

- Examples of our high impact papers include: Nature (19), Science (4), and Cell (9), Lancet (7) and Lancet Oncology (6), Cancer Cell (4), Cell Stem Cell (6), J Clin Oncology (23) and Blood (37)
- Key Centres: CRUK Centre of Excellence, the Experimental Cancer Medicine Centre, the Ovarian Cancer Action Research Centre, the Centre for Systems Oncology and Cancer Innovation, the Comprehensive Cancer Imaging Centre, and the MRC CSC
- Total research income over period: £71.6M
- No. of Early Career Researchers: 13

The Cancer theme incorporates: epigenetics & stem cells; cancer cell signalling; gonadal biology; molecular imaging & pathology; and receptor signalling. We have established major new collaboration with the ICR, initially focussing on metabonomics, epigenomics and bioinformatics (Centre for Systems Oncology and Cancer Innovation [2012]) and won, and renewed, CRUK Centre status (with research themes of surgery & robotics; cancer imaging & molecular phenotyping; molecular cell biology; population, behaviour & health service).The MRC CSC has cancer research embedded throughout their themes of epigenetics, integrative biology and genes & metabolism. The Haematology Centre co-ordinates the largest clinical practice in Chronic Myeloid Leukaemia (CML) in Europe, focussing on molecularly targeted therapies.

Key achievements of the Cancer group:

- Insight into maintenance of genomic stability during DNA replication and repair (*Aragon*, Nature 2013, Science 2011; *Speck*, Mol Cell, 2013) and role of epigenetic mechanisms in cancer and stem cells (*Gil*, EMBO J 2013; *Bartke*, Cell 2010)
- Discovery of novel anti-cancer targets (*Stebbing*, Nature Med 2011; *Gabra*, Cancer Discovery 2012; *Uren*, Cell 2008) and established cross-College cancer drug discovery and development group (CD^3; *Coombes,* Barrett [UoA 8]) with hit to lead development of 2 kinase inhibitors
- Identification of novel genetic and epigenetic biomarkers in clinical studies (*Flanagan*, Cancer Res 2011; *Coombes*, Genome Res 2012; *Brown*, Clin Cancer Res 2011, Nat Genetics 2010)
- Clinical evaluation of functional PET imaging (*Aboagye*, PNAS 2009; *Kenny,* J Nucl Med 2008)
- Clinical trials that changed national practice (*Coombes*, J Clin Oncol 2013; *Seckl*, Lancet 2010)
- Renewal of CRUK/NIHR Experimental Cancer Medicine Centre (*Brown*, *Seckl*, 2012-2017) supporting Cancer Biomarker Resource Centre, Early Cancer Trials Unit (*Blagden*)
- Renewal of Ovarian Cancer Action Research Centre (*Brown, Gabra,* 2012-2017) in partnership with Royal Marsden Hospital and ICR
- Demonstrated that poor response to tyrosine kinase inhibitors (TKI) in CML could be identified early using RT-PCR (*Apperley*, *Goldman*, *Marin, Rezvani*)
- Identified interconvertible phenotypic and functional states of myeloma-propagating cells (*Auner, Kararadimitris*)
- Uncovering critical mechanisms regulating stem cells, differentiation and reprogramming (*Bond*, *Dillon*, *Fisher*, *Gil*, *Hajkova*, *Pombo*)

Plans for the next 5 years:

- Further develop Imperial College/ICR collaborations building on the Centre for Systems Oncology and Cancer Innovation in 2013
- We shall expand our cross-departmental and cross-faculty interactions through our recently renewed CRUK Centre
- Alignment with the pan-London Lung Cancer Alliance, with ICR, Kings Health Partners and the Francis Crick Institute will broaden our reach in 2014 onwards
- The newly awarded CRN NW London, hosted by Imperial, will now allow integration of our cancer clinical trials with the Royal Marsden Hospital, under ICHP; this will allow us to expand

our trials into multiple myeloma and lymphoma from 2014. The AHSC is investing in the Imperial Molecular Pathology laboratory to provide genome based diagnostics across NW London from 2015 through ICHP

Cardiovascular Medicine

- Examples of our high impact papers include: NEJM (22), Lancet (34), Nature (5), Nature Genetics (17), Science (1), JAMA (13), and BMJ (13)
- Key Centres: British Heart Foundation (BHF) Centre for Research Excellence, the BHF/MRC Centre for Regenerative Medicine and the NIHR Cardiovascular BRU
- Total research income over period: £104.3M
- No. of Early Career Researchers: 10

Cardiovascular Medicine has been consolidated into 2 broad themes: Vascular Science and Heart Failure. All of the discovery science groups have relocated to the new ICTEM building. There are 3 BHF Chairs (*Angelini, Haskard, Schneider*), 2 BHF Centres and strong links with the pharmaceutical industry in the performance of clinical trials (AMGEN, Pfizer).

Key achievements of the Cardiovascular Medicine group:

- Fundamental study of myocardial disease leading to novel gene and cell therapies, including treatment of patients in first UK cardiac gene therapy trial using SERCA2 (*Harding*, *Lyon*)
- Identification of rare and common genetic variations of *titin* in cardiomyopathy (*Pennell, Cook* NEJM, 2012) and population-based GWAS analyses related to cardiovascular disease risk utilising the LOLIPOP cohort (*Kooner* and *Scott*, Nat Gen 2008, 2010, 2011)
- Molecular dissection of underlying mechanisms of vascular inflammation, angiogenesis and atherosclerosis (*Haskard and Botto,* Circulation 2009, 2010; *Birdsey*, Blood 2012; *Randi,* Blood 2011; *Mitchell,* PNAS 2012, *Boyle,* Circ Res 2012)
- Publication of the ADVANCE trial, undertaken within the interdisciplinary International Centre for Circulatory Health (*Poulter* NEJM 2008; 2258 citations since 2008 [Scopus, 25th Nov 2013])
- Advancing the biomarker discovery in pulmonary hypertension through advanced imaging (*Wilkins*, AJRCCM 2013; *Zhao,* Circulation 2013)
- Collaboration with Bayer to develop the soluble guanylate cylase stimulator, Riociguat for pulmonary hypertension, recently approved by FDA (*Ghofrani* and *Wilkins*, NEJM *2013*)
- The BHF Centre for Research Excellence award (£12M; *Schneider* [Director], 2008-2018) bringing together cardiovascular, biophysical and computational sciences
- Major capacity-building initiative in Regenerative Medicine, funded in a joint investment of over £10M between Imperial, the BHF and the MRC (Harding [Director], 2012-2017)
- Our recruits: *Angelini* (BHF Chair), *Brand*, *Camm*, *Cleland*, *Diller*, *Ghofrani, Knoll*, *Kohl* (BHF Senior Fellow), *Leiper*, *Serruys*, *Steg*, *Swedberg*, *Thum*, and renewal of BHF Chair (*Haskard*)

Plans for the next 5 years:

- Alignment with 2012 UK Strategy for Regenerative Medicine and the BHF Mending Broken Hearts initiative achieved through the BHF Regenerative Medicine Centre (~£3M)
- Joint development in 2014 of the novel Cardio-Oncology Initiative (*Lyon*) at the NIHR Cardiovascular BRU addressing heart failure induced by cancer therapy
- Consolidate our major trials through long-term follow-up: ASCOT, ASPIRE, EUROASPIRE EUROACTION, UMPIRE (polypill); complete CUPID2 and SERCA-LVAD gene therapy trials (*Harding*, *Lyon*); establish new trial (FOURIER-AMGEN) on PCSK9 inhibition (*Poulter, Sever*)
- Map the occurrence and outcome of Takatsubo syndrome (acute stress-induced heart failure) via the newly added fields of the MINAP database (*Lyon*)
- Create a strategic Centre for Vascular Sciences, integrating vascular research at Hammersmith (*Haskard*, *Wilkins*), RBHNT (*Mitchell*) and St Mary's (*Sever*)

Computational and Systems Medicine

- Examples of our high impact papers include: Nature (2), Science (1) and PNAS (7), Nature Protocols/Methods (5) and highly cited reviews in Nature (1), Science (1), Cell (1)
- Key Centres: MRC/NIHR National Phenome Centre, the NIHR Imperial BRC Clinical Phenotyping Centre and the MRC/PHE Centre for Environment and Health
- Total research income over period: £27.1M
- No. of Early Career Researchers: 3

Since 2008, the Computational and Systems Medicine theme has expanded significantly and established, in strong collaboration with industry, one of the most extensive metabolic research facilities in the world including 13 state-of-the-art high field NMR systems and 49 mass spectrometers in the MRC/NIHR National Phenome Centre and the NIHR Imperial BRC Clinical Phenotyping Centre. We have developed new initiatives in Gut Health, Surgical Metabonomics and Molecular Epidemiology.

Key achievements of the Computational and Systems Medicine group:

- Launching the NIHR Imperial BRC Clinical Phenotyping Centre, the first metabonomic laboratory which placed MS/NMR in a hospital environment, allowing real-time applications, e.g. the i-Knife (*Takats,* Sci Trans Med 2013; *Nicholson*, Nature 2012)
- Developed strategic alliances with commercial partners (Waters [£6.5M], Bruker [£4.5M])
- Created a new unit of computational medicine to address analysis of advanced chemical phenotyping (linked to the Centre for Systems Oncology and Cancer Innovation)
- Developed the Metabolome-Wide Association Study (MWAS) approach to map metabolic phenotype variation in relation to cardiovascular disease risk (*Holmes*, Nature 2008)
- Investigation of maternal nutrition and microbiome on growth and development (*Li,* Science 2013) and analysis of host-microbiome functional metabolic interactions (*Nicholson*, Science, 2012, 2013; *Nicholson* and *Holmes*, Cell 2008)
- The Consortium for Metabonomic Toxicology (COMET) with major Pharma companies (Servier, Bristol Meyers Squibb, Roche, Pfizer, Sanofi) resulted in adoption of expert system by several of the companies (*Holmes, Lindon*, *Nicholson*)
- Development and application of pharmacometabonomics for prediction of patient centred responses that will enable personalised medicine (*Nicholson,* Nature 2012, PNAS 2012)

Plans for the next 5 years:

- Establish partnership with the European BioInformatics Institute in 2014 to form an analytical engine for the MRC/NIHR National Phenome Centre through acquisition of software engineers for converting new algorithms and data visualization
- Develop a Centre for Gut Health in 2013 (following recruitment of *Marchesi* and *Li*) with initial focus on the interaction of the microbiome and host metabolism (*Li,* Gut 2012; *Holmes,* PNAS 2012) and extending to examine the impact of bariatric surgery
- Development and implementation of phenotypically augmented clinical trials (PACT) for improving the patient cancer journey (*Nicholson*, Nature 2012)

Diabetes, Endocrinology and Metabolism

- Examples of our high impact papers include: Science (4), Nature (7), PNAS (18) and NEJM (2)
- Key Centres: Imperial Centre for Endocrinology (*Bloom*), Centre for Nutrition (*Frost*), Centre for Endocrine Biology (Froguel [UoA2]), Bone Degeneration Group (*G Williams*), Cell Signalling in Diabetes & Obesity (*Withers*)
- Total research income over period: £61M
- No. of Early Career Researchers: 8

The Diabetes, Endocrinology and Metabolism theme applies our genetics, epigenetics, cell biology, metabolic, animal models and clinical trials to the treatment and prevention of a range of common metabolic diseases, consolidated on the Hammersmith campus. New recruits include *Frost* (nutrition), *Ferrer (*epigenetics, WT Senior Investigator, Cell Metab 2012) and *Withers* (signalling pathways, WT strategic grant holder, Science 2009). A strong collaboration exists with Engineering for monitoring and control of metabolism (*Bloom,* Toumazou [UoA13a]).

Key achievements of the Diabetes, Endocrinology and Metabolism group:

- Developed long-acting, high potency analogues of satiety gut hormones to provide a therapeutic "medical bypass" (MRC>£10M) exploited in a new spinout company (*Bloom*, Diabetes 2013; *Dhillo*, Cell Metab 2011)
- €7M European Research Council (ERC) Synergy grant awarded to work with Electrical Engineering (*Bloom*, Toumazou) mimicking vagal satiety signals in man
- Development of mouse models and imaging technologies for targeting insulin secretion in type 2 diabetes (*Rutter,* Nat Meth 2009, WT Senior Investigator £2.2M, MRC £1.5M)
- Identification of a copy number variation responsible for a gene dosage effect causing extreme obesity or leanness (*Blakemore,* Nature 2010*,* Nature 2011)

- Identification of signalling pathways regulating mammalian lifespan (*Withers,* Science 2009, WT Strategic Award £4.8M 2012)
- *Frost* has developed novel nutritional solutions, including food ingredients, targeted at gut nutrient receptors that suppress appetite (BBSRC, £1M)
- *Williams* and *Bassett* have identified novel *genes* that determine susceptibility to bone fracture using the mouse knock-out consortium at the WT Sanger Institute and have generated a conditional TR knockout and specific type III deiodinase over-expressing mice to determine action of T3 actions in bone (*Williams,* PNAS 2010, WT Strategic Grant £2.6M)
- To improve care of diabetes, the therapeutics group has developed the Bioinspired artificial pancreas (*Johnston* Lancet Diab & Endocrin 2013) and successfully tested it in the clinic
- The phase I trial of kisspeptin stimulation in IVF has induced pregnancy and a healthy child (*Dhillo,* J Clin Endocrin Metab 2009, NIHR Fellowship £1M)
- National Diabetes Research Network (*Johnson* [Chair]) established with genomics*,* epigenetics, cell biology, animal models and clinical research, including an artificial pancreas

Plans for the next 5 years:

- Establishing high throughput platforms to identify both endogenous and exogenous modulators of our identified diabetes and obesity related genes
- Testing the efficacy as insulin secretalogues and adipose reduction of our newly developed high potency oxyntomodulin and PYY analogues in phase I-II clinical trials, from Q1 2015
- Exploiting the bariatric surgery BioResource to seek new genetic causes of obesity and to identify genetic and genomic factors influencing response to “metabolic” surgery
- Capitalising on the new programme of screening at the Sanger murine programme to identify new genetic associations controlling bone strength (*Williams,* WT Strategic Award £6M, 2013-)

Infection, Immunology and Inflammation

- Examples of our high impact papers include: Science (15), Nature (19), PNAS (48) and NEJM (7)
- Key Centres: MRC Centre for Molecular Microbiology and Infection (CMBI), UK Clinical Research Collaboration (CRC) Centre for Infection Prevention and Management (CIPM), Imperial WT Centre for Global Health Research, National Centre for Human Retrovirology and the Centre for Cell Signalling and Inflammation
- Total research income over period: £163.5M
- No. of Early Career Researchers: 23

Infection, Immunology and Inflammation research shares the common aim to integrate fundamental discovery science with clinical medicine to treat or prevent diseases of global importance, across microbiology, virology, autoimmunity and inflammation. Infection comprises 50 academic staff including 6 WT investigators (*Allday, Bangham, Grundling, Holden, Screaton and Wigneshweraraj*) and forms one of the largest centres for infectious disease research in Europe with an annual research spend of >£25M. Since 2008, Imperial has made major investments aligned to the award of the MRC CMBI (£4M), the UK CRC CIPM (£4.6M) and the Imperial WT Centre for Global Health Research (£0.75M). Immunology and Inflammation researchers focus on basic immunological mechanisms and translate through our translational centres: the Centre for Cell Signalling and Inflammation; the Centre for Complement and Inflammation Research and the Robert Hesketh Hepatology Research Unit apply these findings to inflammatory disorders of the kidney, joint, liver and gastrointestinal tract, with a particular focus on vasculitis, disorders of complement regulation and the contribution of inflammatory pathways.

Key achievements of the Infection, Immunology and Inflammation group:

- The MRC CMBI has discovered new antimicrobial targets (*Holden,* Science 2012; *Grundling,* PNAS 2013; *Wigneshweraraj,* Mol Cell 2012)
- We have established the Imperial WT Centre for Global Health Research (2012 WT £0.75M) through partnerships with academic institutions in Africa, Asia, and Latin America
- Our solution of the crystal structure of the retroviral integration complex has facilitated design of new HIV *integrase* inhibitors (*Cherepanov*, Nature 2010; *Maertens*, Nature 2010)
- We have made advances in tuberculosis research both in the UK and overseas (Peru, Gambia, Uganda, South Africa, Former Soviet Republics) including: pathogen genetics (*Young*, PLoS Path 2011), immunopathology (*Friedland,* JCI 2011), diagnosis (*Kampmann*, AJRCCM 2012;

Evans, PLoS Med 2008, WT Career Development Award); TB treatment, IRIS and drug resistance (*Wilkinson*, AJRCCM 2008, WT Senior Fellow 2012; *Drobniewski*, Lancet 2009)

- Our virology research is strongly focused on oncogenic viruses, especially herpes viruses (*Allday, Farrell, Ojala*), hepatitis viruses (*Dorner, Thursz* NIHR STOPAH £2.3M, EU PROLIFICA £2.5M) and retroviruses (*Bangham, Kassiotis, McClure, Shattock, Stoye,* EU FP7 £1.7M, £1M). We identified viral EBV genes responsible for latency and transformation (*Allday*, PLoS Path 2013; *Farrell*, PLoS Path 2011; *White*, JCI 2012) and determinants of influenza virus tropism and pathogenicity (*Barclay*, PLoS Path 2009, WT Programme £1M; *Chai*, Nat Biotech 2010; *Xu* Nat Med 2011)
- We have elucidated molecular mechanisms of poxvirus infection and developed rapid response to deal with emerging poultry viruses (*Skinner*, J Virol 2010, 2013, 2013, BBSRC £5M)
- In HIV research, we have reported major international clinical trials that have influenced care: MDP 301 (Weber [UoA2], Lancet 2010,MRC/DfID £42M); SPARTAC (*Fidler*, NEJM 2013, WT Strategic Award, £7.8M) and DART (Gilks [UoA2], Lancet 2010, MRC/DFiD £4.5M)
- Imperial hosts the International AIDS Vaccine Initiative (IAVI) Human Immunology Laboratory (Gilmour [Director], £7.9M) which supports HIV vaccine development and trials (Weber, J Exp Med 2008, WT Strategic Award £8.7M). We work on protective and pathogenic immune responses and their public health implications: HIV (*Kampmann,* JAMA 2011, NIHR Senior Fellow; *Shattock,* PLoS Med. 2008, EU FP7 £1.7M); Meningococcus (*Kroll*, PNAS 2010; *Pelecic*, Vaccine 2011)
- We have reported antibody T cell response in natural human dengue infection (*Screaton*, Science 2010) and animal models of Hepatitis C (*Dorner*, Nature 2011, 2013)
- We have identified genetic susceptibility loci to meningococcal and Kawasaki disease (*Levin*, Nat Genet 2011, 2012, EU FP7 £10.2M) and our trials have challenged the management of paediatric sepsis (*Levin*, NEJM 2012; *Modi,* Lancet 2009) and sickle cell disease (*Williams*, Lancet 2009, WT Senior Fellow)
- The Cell Signalling group study the molecular basis of immune cell signaling (*Gallagher*, Science 2008; *Tybulewicz*, Science Signaling 2009; *Ley*, Nat Immunol 2009; *Franzoso,* Nat Cell Biol 2011) and translate these findings to novel therapeutics (*Franzoso*, Kesios Therapeutics, £1.1M CRUK and £4.5M MRC pipeline awards)
- We study complement dysregulation in renal disease (*Pickering*, J Clin Invest 2008, WT Senior Clinical Fellow; *Botto*, Cell 2012), with first description of C3 glomerulopathy disease (*Pickering*, Lancet 2011), discovered the genetic basis of macrophage activation (*Behmoaras*, Nat Gen 2008) and ANCA vasculitis (*Pusey*, NEJM 2012) and clinical trials in systemic vasculitis that have altered the approach to management (*Pusey*, Ann Intern Med 2009)
- Pre-clinical models have identified novel innate immune pathways in macrophages (*Woollard*, Immunity 2010), and cross-talk between innate and adaptive immunity in the skin (*Strid*, Science 2011, WT New Investigator)
- CIPM has identified novel diagnostics (*Sriskandan*, JID 2009) and decision support software for antimicrobial prescribing (*Holmes*, Lancet Inf Dis 2011)
- Glycosciences provides a unique carbohydrate microarray facility for discovering sugars involved in cellular recognition (*Chai,* Nat Biotech 2010, WT £1.2M Carbohydrate Microarray)
- Our new recruits: *Batista, Clarke, Dorner*, *Edwards, Gallagher*, *Kassiotis*, *Ley*, *Mostowy*, *Ojala*, *Rueda*, *Shenoy*, *Stoye*, *Strid*, *Tybulewicz*, *Ulijasz*, *Woollard*, and *Xu*

Plans for the next 5 years:

- Establish a Centre for Human Oncogenic Virology with the ICR in 2014
- Lead a new Human Vaccine initiative in 2015: *Shattock*, *Xu*, Gilmour, *Screaton*, Weber in conjunction with IAVI and Novartis
- Enhance infection trials capacity from phase I-III, with ICTU
- Create an antibiotic discovery centre, capitalising on the MRC CMBI, CIPM and industry links
- Develop a multidisciplinary centre for immune signalling with reference to autoimmunity, cancer and metabolic syndrome

Respiratory Medicine

- Examples of our high impact papers include: NEJM (8), Lancet (17), Nature Genetics (9), Science (2), JAMA (4), Nature Medicine (4), PNAS (10), and BMJ (5)

- Key Centres: MRC/Asthma UK Centre in Allergic Mechanisms of Asthma, the MRC/PHE Centre for Environment and Health, the NIHR Respiratory BRU, the Imperial Clinical Respiratory Research Unit and the WT Centre for Respiratory Infection
- Total research income over period: £90.8M
- No. of Early Career Researchers: 13

The Respiratory Medicine group has the largest critical mass of respiratory researchers within the UK. There are two broad themes: respiratory infectious diseases on the St Mary's campus and chronic lung disease, including asthma and chronic obstructive pulmonary disease (COPD) at the Brompton with respective alignment of clinical services. There are currently three WT senior investigators (Cookson [UoA2] & *Moffatt* jointly and *Rankin*), Asthma UK Chair (*Johnston*), strong industry collaboration with GSK, AstraZeneca, Pfizer, with notable spin-out companies RespiVert (*Barnes*) and Circassia (*Kay*); and development of the NIHR Respiratory BRU to facilitate translational research in lung disease.

Key achievements of the Respiratory Medicine group:

- Under the lead of *Alton*, *Griesenbach* and *Davies* the first trial of gene therapy in cystic fibrosis (AJRCCM 2012) has completed safety and single dose trials to the lungs and the largest multi dose lung gene therapy trial has commenced (MRC £5M)
- NIH Immune Tolerance Network funded trial of sublingual immunotherapy, the first allergy vaccine to be registered in UK for 35 years (*Durham*, JACI, 2008, 2011, 2012)
- Investigation of the molecular mechanisms of corticosteroid resistance in COPD (*Barnes, Adcock,* AJRCCM 2010, JCI 2011) has led to an Imperial spin-out company (RespiVert) which has developed novel inhaled therapies for COPD, acquired by Johnson & Johnson for >£100M
- WT-funded MOSAIC consortium of research groups, led by *Openshaw*, studied hospitalised patients with Influenza H1N1/09 infection following the global pandemic involving 45 co-investigators in 8 cities (Nature 2012) leading to novel insights into the natural history of 'flu
- Human challenge models of RSV and rhinovirus infection are carried out in the respiratory CRF with brochoscopic examinations to study mucosal in addition to systemic responses (*Johnston*, Nature Med 2008, PNAS 2008; *Openshaw*, PNAS 2013 x2)
- Advanced studies on both human and mouse models of asthma exacerbations which have led to an MRC/GSK Strategic Alliance award (*Johnston*) of £6M
- Studies on H1N1 infection have led to better understanding of flu infection and the potential development of a universal flu vaccine (*Lalvani*, Nat Med 2013)
- Development of novel metagenomics technology to study bacterial colonisation of the lung (*Johnston, Moffatt*, *Openshaw*) has demonstrated that thoracic airways are not sterile and contain a characteristic flora disturbed in asthma and COPD (PLoS One 2010)
- *Moffatt* (and Cookson) co-ordinated the international GABRIEL project which identified genes and environmental factors in asthma in Europe (NEJM 2011) and contributed original data to landmark gene identifications in asthma (NEJM 2009)
- Our new recruits: *Bowcock, Carlin*, *Dean*, Lovett (UoA 4), *Natanek, O'Garra*

Plans for the next 5 years:

We plan to maintain our high international profile with a specific focus on developing networks to study disease phenotypes and natural history by collaborating with appropriate partners (*Alton* National lead for respiratory rare diseases). Three centres of excellence will be formed in 2013:

- Chronic Lung Disease Centre: COPD Centre (*Adcock, Barnes*) with focus on phenotyping, abnormal signalling pathways and novel therapeutic targets, expansion of severe asthma research through the UBIOPRED IMI consortium (*Chung*) and completion of multi-dose and phase III trial of gene therapy in cystic fibrosis
- Genetics and Genomics Centre: epigenome wide association and functional studies in asthma and other disorders, including ILD and single gene disorders (Cookson, *Moffatt*), genomic technology development (Lovett), development of genetic studies in cancer (*Bowcock*) and further investigation of the lung microbiome
- Respiratory Infection Centre: Featuring development of human virus challenge studies (*Johnston*, *Openshaw*) to include RSV, influenza and rhinoviruses, including developing unique capability in rhinovirus challenge model of COPD exacerbations

Surgery and Surgical Technology

- Examples of our high impact papers include: Annals of Surgery (67), Lancet (20), BMJ (27), NEJM (11) Nature (4), Nature Genetics (7), and Science Translational Medicine (1), JAMA (2) and PNAS (3)
- Key Centres: Surgical Innovation Centre, the Hamlyn Centre for Robotic Surgery, the Rothschild Clinical Simulation, Training and Assessment Research Centre, the Centre for Patient Safety and Service Quality, the Institute of Global Health Innovation and the Centre for Health Policy and the Surgical Metabonomics Laboratory in the NIHR Imperial BRC Clinical Phenotyping Centre
- Total research income over period: £66.6M
- No. of Early Career Researchers: 8

The Surgery theme has expanded since 2008, with significant support from the Hamlyn Trust (>£10M), WT (£5M) and the EPSRC (£7M), and continues to be highly collaborative with the Department of Computing in the Faculty of Engineering. We have continued to build on our productive and strong partnership with ICHNT to ensure integration of research innovation with healthcare delivery. We have developed new initiatives in Surgical Metabonomics with the Computational Systems Medicine theme through establishment of a dedicated NIHR Imperial BRC Clinical Phenotyping Centre at St Mary's Hospital.

Key achievements of the Surgery and Surgical Technology group:

- *Darzi* (and Yang [UoA15]) have developed i-Snake®, a robotic flexible surgical tool that improves safety and enhances the precision and dexterity of surgeons
- *Bicknell*, Greenhalgh (UoA 2) led the largest clinical trial in endovascular surgery, EV Aneurysm Repair in patients with abdominal aortic aneurysm (*Bicknell*, NEJM 2010)
- *Atkin* proved that a single flexible sigmoidoscopy screen produces a substantial reduction in colon cancer incidence and mortality; Flexisig has been approved by the UK National Screening Committee and is part of the Bowel Cancer Screening Prog (*Atkin*, Lancet 2010)
- *Cobb* has developed active constraint robot technologies which augment surgeon skills (*Hart,* J Bone Joint Surg Am 2012); the spin-out 'Acrobot' was acquired by Stanmore Implants in 2010
- A novel multi-probe bipolar radiofrequency device (Habib 4X™) has been developed to assist liver resection and to reduce intraoperative blood loss (*Habib*, Ann Surg 2009)
- Early results of 'i-Knife', an electrosurgical knife connected to a mass spectrometer shows it can detect and differentiate cancer tissue in real time (*Takats*, Sci Trans Med, 2013)
- Implementation of the World Health Organisation (WHO) 'Safe Surgery Saves Lives' pilot study and WHO Safe Surgery Checklist study (*Darzi*, *Sevdalis, Vincent*) significantly improved patient outcomes and is mandated in all NHS surgical procedures by the NPSA (*Haynes,* 2009).

Plans for the next 5 years:

- Surgical Technology: Darzi with Engineering (Yang, Elson [UoA15]), focus on the fusion of endoscopic imaging with MRI for safer surgical intervention as part of CRUK Centre
- Build on recent advances in real-time diagnostics with direct clinical application in surgery (i-Knife, i-E*ndosc*ope, i-*Snake), Darzi* with *Nicholson*, *Holmes*, *Takats*
- Translation research platforms in surgery: Clinical trials to translate the technology platforms into clinical practice, to reduce the trauma of access and transform endoscopic surgery from intra-cavity to endo- or trans-luminal surgery
- Strengthen the relationship with the Royal College of Arts, utilising design expertise in the creation of novel instrumentation
- Safety and Quality of adoption of innovation in surgical practice: expand the novel systems approach to surgical safety research, through innovative design and technology

Evidence of multi- and/or interdisciplinary developments

Since RAE2008, one of the most significant developments at Imperial has been the highly productive cross-Faculty and cross-HEI collaborations which have been established. Imperial is a partner in the new Francis Crick Institute, a new £700M interdisciplinary medical research consortium of 6 of the UK's most successful scientific and academic organisations, the MRC National Institute for Medical Research, the CRUK UK London Research Institute, WT, Imperial, UCL and KCL. Imperial is committed to placing clinical academics and trainees into the Institute, with a clinical base in ICHNT. The Institute will greatly strengthen the UK fundamental bio-medical

research base and will be strongly supported by the three London AHSCs and their HEIs in order to promote translation out of the Francis Crick Institute.

Four MRC Centres are jointly held between Imperial and KCL: the MRC/Asthma UK Asthma centre, the MRC/NIHR Phenome Centre, the MRC/PHE Centre for Environment and Health and the Centre for the Developing Brain. The London Centre for Nanotechnology, jointly held between Imperial and UCL, is developing novel nano-scale diagnostics and materials. Imanova represents an initiative jointly owned by Imperial UCL, KCL and the MRC providing integrated capacity for PET and MRI imaging – the first functioning fully pan-London structure. The Centre for Systems Oncology is held jointly with the ICR.

We have used the NIHR BRCs collaboration to drive coordinated research across the five HEIs/AHSCs at Oxford, Cambridge, UCL, KCL and Imperial; this is exemplified by the common BioResource, the integrated NIHR health informatics consortium (NHIC) and by jointly winning external MRC funding for pan-BRC projects such as the HIV eradication project, CHERUB. The London AHSCs plus Oxford and Cambridge formed the Global Medical Excellence Cluster in 2008, in order to collaborate with the pharmaceutical industry, to promote wealth generation across the five AHSCs and to facilitate cooperation in presenting healthcare research and delivery externally.

Our intramural biomedical research is supported by interdisciplinary research hubs focussing on improving healthcare. Key examples include the Institute of Biomedical Engineering (IBME) Research Technology Networks, which draw together researchers from all disciplines across Imperial to promote and coordinate multi-disciplinary research programmes for generation of novel IP in specific therapeutic/disease management areas that will benefit patients. IBME includes the Cardiovascular Technology, Metabolic and Endocrine Technology, Musculoskeletal Technology and Bioinformation Technology Networks and the Neurotechnology Initiative. The Centre for Synthetic Biology and Innovation is an EPSRC funded partnership with KCL, focussing on an engineering framework for the design and optimisation of new synthetic biology parts, devices and systems, and applying synthetic biology to develop a wide range of novel biotechnologies. The Centre for Medical Engineering Solutions in Osteoarthritis, funded by the WT and EPSRC, brings together engineers, surgeons, rehabilitation therapists and scientists to focus on the early detection, intervention and prevention of osteoarthritis. The Royal British Legion Centre for Blast Injury Studies comprises engineers, scientists and military doctors fostering collaborative research with bioengineering companies to design and build Paralympic sporting equipment and enable greater independence for those with substantial disabilities; this Centre is closely linked to the Imperial Centre for Traumatic Brain Injury (UoA4). The Centre for Bio-Inspired Technology uses the application of engineering technologies to provide personalised healthcare devices for chronic disease management, developing novel methods for the continuous, real-time sensing or monitoring of bio-chemicals or bio-signals in areas such as genetics, metabolic, neural and cardiovascular disease, such as the Bio-inspired Artificial Pancreas. We have multidisciplinary research programmes in imaging, including the generation of next generation imaging capabilities (*Merkenschlager*, French [UoA9]), 2-photon approaches, and single molecule imaging, quantum dots and tracer development. Excellent research capabilities in computer science, systems medicine/biology, epidemiology, biostatistics, e-Health and medical bioinformatics reside across all three medical UoAs at Imperial, including the MRC/PHE Centre for Environment and Health.

Responsiveness to national and international priorities and initiatives

Our investigators have played key roles in major National healthcare priorities and initiatives: for example, *Openshaw* led the National MOSAIC consortium to address the pathogenesis of the H1N1/09 Influenza epidemic and sat on the Government's Special Advisory Group on Epidemics (SAGE). *Aitman* was specialist advisor to the House of Lords Science and Technology Committee, Genomic Medicine Inquiry; the UK CRC CIPM (*Holmes*) addressed hospital acquired infection through new diagnostics and antibiotic prescribing guidelines; the MRC CMBI (*Holden*) has identified two new antibiotic targets, addressing the NHS priority for novel antibiotic development; our major clinical trials in HIV infection (DART, SPARTAC [case study]) have laid the foundation to address how antiretroviral therapy might be used strategically to reduce HIV transmission.

In cardiovascular disease prevention, the ASCOT trial and the MyAction programme (case studies) address both drug and non-medical interventions to reduce disease. The priority to address obesity has been addressed by our metabolic researchers, who are developing novel peptide drugs to stimulate satiety (*Bloom*, Thiakis [case study]). Our Respiratory investigators have

addressed the factors causing exacerbations of COPD (*Barnes*, *Johnston*); finally, there has been a consistent governmental and public emphasis on patient safety in the NHS which has been addressed by Imperial researchers through the recently renewed NIHR Patient Safety Centre (*Vincent*, *Darzi*) and through the WHO Surgical Safety Checklist (case study)

Our researchers are heavily involved in international consultations; examples include: WHO Advisory Panel on Biological Standardization (*Bloom*), Qatar National Cancer Research Strategy (*Brown, Darzi* [Advisor]), WHO's Envoy for Patient Safety (*Donaldson*), WHO Independent Monitoring for the Polio Eradication Programme (*Donaldson* [Chair]), StopTB/WHO campaign (*Kampmann* [Advisor]), WHO-UNAIDS HIV Vaccine Advisory Committee (*Shattock*), Scientific Advisory Boards of the IAVI (*Shattock*), South African and Chinese AIDS Vaccine Initiatives (*Shattock*), ANRS HIV Vaccine Research Program (*Shattock*), WHO Patient Safety Committee (*Vincent* [Advisor]); UK Government Scientific Advisory Group for Emergencies and Scientific Pandemic Influenza Advisory Committee (*White*), WHO Informal Network for Mathematical Modelling (*White*), and President Obama Consultation Global Health Initiative (*White*).

Effective mechanisms for the development, promotion and dissemination of research

Our Imperial College and NIHR Imperial BRC websites represent our first portal for dissemination and communication. The NW London CLAHRC (£10M, 2008-13; £10M, 2013-2018) has public engagement as one of its major programmes of activity, with a series of PPE events locally and across London. The Imperial Patient Experience Research Consortium (PERC) is funded by the NIHR Imperial BRC and Imperial College Hospitals Trustees as a collaboration of epidemiologists and social anthropologists to explore the basis of patient experience and undertake interventions to enhance experience across ICHNT. We support an annual research festival with ICHNT to promote our research with our staff, patients and the public. We also contribute to the annual Imperial Science Festival, attended this year by >12,000 members of the public. *Kneebone* was awarded a WT Public Engagement Fellowship to develop surgical simulation and its application to public understanding of surgery.

The IGHI Global Health Policy Summit, a new initiative catalysing and supporting global health, was held in Aug 2012 at Guildhall, London attended by over 500 health leaders from 40 countries, with speakers including Prime Minister David Cameron. This year's summit, the World Innovation Summit for Health (WISH) will be held in Dec 2013 in Doha, under the patronage of Her Highness Sheikha Moza Bint Nasser of Qatar.

The Reach-Out Lab at South Kensington hosts >2,000 school students/term (Lord Winston [Director]) and aims to attract more secondary students to take Science A-levels and pursue a scientific/engineering/medical career; this links to our educational programme for school children encouraging engagement with science (*Athersuch*, *Keun*, *Saric*).

Sustaining and developing an active and vital research culture

All our research is managed through a single Imperial AHSC Research Committee (RC, Weber [Chair]), which reports both to the Faculty Board and the ICHNT Management Board; the RC represents all of our UoA1, 2 and 4 research themes and the Faculties of Engineering and Natural Sciences, our hospital partners and our NIHR centres/units. The RC is responsible for strategy, direction and oversight of the NIHR Imperial BRC, coordinating major awards and preparing staff for major fellowship awards, including coaching and practise for WT Investigator awards, ERC fellowships and strategic awards. The RC actively promotes research across the Faculty through managed internal competitions for: Imperial Junior Research Fellowships, Imperial PhD Scholarships, Lectureships, BRC projects and the Joint Translation Fund. Specifically, the RC facilitates the direct pull-through of research into clinical implementation through the AHSC.

In 2013, Imperial assumed leadership of the NW London CRN; Imperial College Health Partners has consequently established a research committee (Weber [Chair]) which aligns all the NIHR funding streams in sector, in order to facilitate dissemination of our research from the BRCs/BRUs across tertiary, secondary and primary care in NW London.

c. People

The College's employees are its primary asset and so we place very high priority on attracting and retaining world-leading academic, research and professional support staff and supporting their careers fully. This, in turn, fosters an intellectually challenging and inspiring environment both for

collaborative science and for the mentoring of young investigators, enhancing our research output.

Since RAE2008, we have recruited 106 Professors, 13 Readers, 75 Senior Lecturers and 63 Lecturers; of these, 78 have been Early Career Researchers in this UoA – representing an investment of over £25M. The Imperial Junior Research Fellowship (JRF) scheme, established in 2009 to identify tenure track academics at the post-doctoral stage, has proven to be extremely attractive; we have appointed 32 JRFs in the Faculty of Medicine, 100% of whom have gone on to win personal external fellowships or secure more senior appointments by the end of their appointments; all our current JRFs within clinical medicine are returned in REF2014.

We have been proactive in promoting our high-achieving staff; since 2008, we have promoted 19 staff to personal Chairs, 22 to Readerships and 20 to Senior Lectureships. Through the AHSC we have recognised the research contribution of 42 NHS consultants to honorary reader and professorial academic appointments in the College. 19 NHS consultants are returned as Category C staff in this UoA, reflecting the quality and integration of the AHSC.

We have prioritised recruitment to our themes and where strategically advantageous, we have made joint appointments; for example, in the Infection, Immunology and Inflammation theme we have made substantial joint appointments with the MRC National Institute of Medical Research (*Kassiotis, Ley*, *O'Garra*, *Stoye*, *Tybulewicz*, *Wilkinson*, *Young*), and with the London Research Institute (*Batista*, *Cherepanov, Reis e Sousa, Way*) who will all migrate to the Francis Crick Institute in 2015. We have further integrated our MRC CSC with UoA1 through 20 jointly appointed academic staff in fundamental cell and molecular biology (*Aitman*, *Aragon*, *Bartke*, *Bond*, *Carling*, *Dillon*, *Fisher*, *Gil*, *Hajkova*, *Lehner*, *Lenhard*, *Martinez-Perez*, *Merkenschlager*, *Miguel-Aliaga*, *Petretto*, *Pombo*, *Speck*, *Uren* and *Withers*). In the Cancer theme, for example, *Brown* has been appointed jointly with ICR; in Computational and Systems Medicine, joint appointments with Surgery (*Takats*) and gastroenterology (*Marchesi*, joint with Cardiff); in Surgery and Surgical technology, *Darzi* co-appointed with ICHNT and the Royal Marsden, Yang co-appointed across medicine and engineering.

We support the full life-cycle of staff engagement from recruitment, to reward and retention, performance interventions, development and career planning. Our strategy recognises that the motivation and retention of all talented staff underpins our success. We identify talent and succession risk and provide clear career pathway development.

To facilitate the capability to translate discovery science directly into health and wealth gains, we make strategic joint appointments across the translational pathway within all research groups and strategic alliances. For example, we have made a number of senior appointments to strengthen industrial links: Solari (jointly with GSK); Hill (ex Merck); Xu (jointly with Novartis) and Want and Wilson (jointly with Waters Corporation).

We have also made a number of international joint appointments, linking to our newly established Lee Kong Chian Medical School in Singapore, jointly created by Imperial in 2010 in partnership with Nangyang Technological University (NTU). *Berggren, Crasta* and *Ingham* have been appointed at NTU with 0.2 FTE appointments at Imperial in order to act as the focus for joint collaborative research in areas of strategic importance for Imperial College.

Implementation of the Concordat to Support the Career Development of Researchers

The importance of our researchers' personal and career development, and lifelong learning, is recognised and supported at all levels within the College. The College has implemented fully the Concordat to Support the Career Development of Researchers and was awarded the European HR Excellence in Research Badge in 2012. Each year, every member of College staff is required to undertake a Personal Review and Development Plan, a two-way discussion between staff member and manager aimed at recognising achievement, providing constructive feedback, and assisting with career development. The College's flexible working policy is applicable to all staff.

Evidence of how the submitting unit supports equality and diversity

We are committed to supporting equality-related activities and resources with dedicated Equalities Unit and support networks, including Imperial as One (race), Imperial 600 (LGBT), and Disability Staff and Student Forums. Equality-related activities are overseen by committees within the College championed by the Vice-Provost (Education). Imperial has a dedicated Equality and Diversity Unit mandated to promote and embed all aspects of equality throughout the College's communities. The College's internal leadership programme for black and minority ethnic (BME)

staff, iLead, has been so successful that HEFCE modelled its Stellar HE, a development programme for diverse (BME) leaders across ten higher education institutions supported by HEFCE's Leadership, Governance and Management Fund, on iLead. A leadership programme for disabled staff, Calibre, has also been established at the College. The College undertakes an annual Disability Survey for Staff. The College continues to be a Stonewall Diversity Champion. The College has ten Departmental Athena SWAN awards (one Gold, seven Silver awards; three of which are represented in this submission), with the College Silver award at institutional level.

The Faculty Ambassadors for Women scheme was established by the College Academic Opportunities Committee in 2007, in order to promote change within the Faculties (*Blakemore*). The Ambassadors provide valuable high-profile role-models, and are also available to help support and advise female academics. The College offers Elsie Widdowson Fellowships to allow female academics to concentrate fully on their research work upon returning from maternity / adoption leave, by relief from teaching or administration for 12 months; 24 Elsie Widdowson Fellowships have been awarded to researchers returned in clinical medicine. We have established a number of Departmental Academic Opportunities Committees to explore new ways to tackle barriers that may exist in academic appointments, career advancement and job satisfaction.

Effective integration of clinical academics and NHS employed active researchers and their roles

147 Clinical academics and 19 Cat C NHS employees are returned in this submission. Sixteen of the 19 NIHR Imperial BRC themes are lead by clinical academics. All NHS consultants have honorary senior lecturer appointments with the College and NHS employed active researchers are also eligible to supervise Imperial post-graduate students and JRFs. Our Business School offers 'mini MBAs' to NHS AHSC staff. In addition, the College acts as a nominating body in the Advisory Committee on Clinical Excellence Awards (ACCEA) scheme. Since 2008, the College has promoted 11 NHS staff to Honorary Professorships and 31 NHS staff to Honorary Readerships, on the basis of research and/or teaching excellence.

The Unit has established a research development scheme providing funding to protect and ring-fence the research time of full-time clinical scientists. There are 257 Clinical Research Fellows funded by the ICHNT, Imperial College Healthcare Charity or other national and international organisations, pursuing shorter term periods of research training with a view to obtaining an MD(Res) or a competitive CRTF. We receive WT funding to support a clinical PhD programme. In 2012, the NIHR awarded *Stebbing* its first translational research professorship in oncology.

Evidence of a sustainable staff structure and career development

We have well supported development plans in place for all staff, a clear understanding of our succession plans for senior staff and an appropriate supply of suitably qualified and skilled staff to apply for, and to be appointed to, senior roles. We build management capability through Imperial Expectations; pragmatic and practical statements which govern staff behaviour. To facilitate succession planning, increase diversity, support retention and enhance our overall performance, capacity building of middle leaders is delivered through selective and targeted talent development programmes (the Management Training scheme, Horizon and Pegasus). To equip senior academic staff with the practical skills and awareness required for organisational leadership, the College runs the Senior Academic Leadership Programme. The programme is based on the National Occupational Standards for management and leadership, and is accredited with the Chartered Management Institute. We measure through qualitative and quantitative evaluation data the enhanced effectiveness and progression and impact of succession plans put in place. Within the return, approximately a fifth of researchers have been promoted during the REF period.

Arrangements for the effective development and support of the research work of staff

The Learning and Development Centre (LDC) provides management and leadership programmes to all College staff and additional tailored development support for the academic community. This includes the Academic Development Centre (support for all aspects of academic achievement), the Female Academic Development Centre (support for women in academic positions), as well as the Senior Academic Leadership Programme. The 'In Conversation' Senior Academic Forum is a regular group where the College's academic leaders meet to discuss current challenges and form solutions to key issues. At a research group level, we have introduced a policy of internal peer review of all grant applications (>£250K) as well as mock interviews for all at

both a research group and Faculty level. The benefits if this investment are already being realised with an almost 30% increase in our MRC grant success rate, and our 20 WT Investigator awards.

Developing the research of Early Career Researchers

Through the Imperial Junior Research Fellowship Scheme, the College provides a level of commitment and support for the best early career researchers that is rare from a UK university. This competitive scheme offers first-rate early career researchers from across the world, a three-year research fellowship with no obligatory teaching or administration, and including generous consumables support. Of the one cohort of completed fellows, 3 have been appointed to lecturer or associate professorial appointments and two have attracted WT project and NIHR fellowship funding. This scheme is supplemented by one additional fellow per annum funded by the WT ISSF. This ISSF scheme also supports 4, one year clinical training fellowships per annum in global health research to provide opportunities for the most promising clinical academics at the very beginning of their careers to develop bids for independent fellowship funding. The first cohort completed in 2013, of which 2 have attracted external fellowship funding. Through both WT ISSF and earlier WT Value in People funding we have also provided bridging support for 45 early and mid career researchers whilst they have applied for externally funded fellowships or research grant funding.

The Postdoc Development Centre (PDC) offers a tailored programme of support to postdocs, helping them meet their contractual obligation to spend 10 days per year on professional development. The PDC provides skills and career development training, a personal development programme designed for women and a range of individual support, including coaching and mock interviews. Since 2009, 210 1-2-1 coaching programmes and 46 mock interviews have been held with Early Career Researchers within UoA1, in addition to those held at a research group level. The centre runs a bespoke development scheme for Imperial's JRFs, publishes a range of guides on postdoctoral issues and hosts the multidisciplinary Postdoc Reps Network. In 2010, the work of the PDC was acknowledged when it was shortlisted for "Outstanding Support for Early Career Researchers" at the Times Higher Education Awards. At a research group level we are rolling out a programme of support for postdoctoral scientists to provide mentoring and training as well as development in understanding, choosing and developing their future careers within the academic field or elsewhere. This has included the appointment of an Academic Lead for Postdoctoral Researchers. A database of current postdoctoral researchers enables specific targeting for fellowship applications. This also enables us to review the support provided at a local level.

Training and supervision of postgraduate research (PGR) students

The College's Graduate School provides an award-winning professional development programme that supports all postgraduate students throughout their study period. Imperial is the only university to have won the Times Higher Education Award for Outstanding Support for Early Career Researchers twice. The Graduate School works with academics and students across College to help build an integrated, interdisciplinary environment and help postgraduates to move on to the next stage in their careers. The Professional Skills Development programme is one of staged learning to ensure that all postgraduate students acquire basic research skills at the start of their doctoral studies (underpinning skills phase) and continue to develop as a well-rounded researcher (consolidating and completing phases). There is an Enrichment section which offers further workshops available at any stage and most students go on to complete several more courses than the compulsory requirement.

Effective and sustainable doctoral research training

Within specific graduate schemes, we have introduced a cohort approach to fostering student-student interactions, thesis seminars to assist and promote timely write-up and senior (non-supervisor) mentoring. For example, the Chain-Florey doctoral students have clinical mentoring to accompany their three years in a non-clinical environment. The students on the WT 4-year PhD programme in Infection are cohorted and mentored by non-supervisor senior staff. Each department also runs widely attended termly "Graduate Student days", to allow students in their third years to present their data through presentations, posters and a judged competition.

We are fully committed to providing excellent researcher development to postgraduate students and postdoctoral researchers as a signee of the RCUK Concordat. The Graduate School and the PDC underpin researcher development by providing a central comprehensive training and

professional development programme for research students and postdoctoral researchers based on researcher needs and research group requirements. The College encourages cross disciplinary teams to come together via the establishment of inter-faculty research institutes, Centres for Doctoral Training, Doctoral Training Centres/Programmes, and Industrial Doctoral Centres. The Graduate School works in partnership with such centres to assist with the provision of training opportunities for research council funded students, for example, by running bespoke courses, advising on new course design and supplying course tutors. The Graduate School's Doctoral Training Governance Committee acts as a forum in which to share good practice across Centres and to provide oversight of and help to coordinate the additional training provided to students by these Centres. For example, the value of establishing peer groups and cohorts has been identified by this committee. The Graduate School is also able to gather information from this committee to inform its own training programme and to ensure that students who do not belong to a Centre are given a comparable learning experience and support.

Evidence of a strong and integrated research student culture

The Graduate School organises International Summer Schools that have developed researchers' global skills and been successful in strengthening collaborative research links with key partner institutions, including MIT. It also organises a range of academic and social activities designed to bring students together in an interdisciplinary environment, with an annual Summer Research Symposium with student posters, prizes and an invited speaker. Within UoA1 we host postgraduate research programmes, both by Department and by campus. For example, virology students have weekly post-grad series in the Wright-Fleming Institute; microbiology students through the MRC Centre for Molecular Microbiology and Infection.

Cross-Cutting Non Clinical Programmes

We have 19 doctoral training accounts from the MRC, BBSRC and EPSRC which involve investigators returned in UoA1, and 32 supervisors are returned within this submission. In addition MRC CSC receives 8 DTA studentships annually directly from the MRC as part of its quinquennial funding. In 2013, the MRC CSC also introduced an Interdisciplinary, Cross-Campus, Collaborative Studentship programme. In 2013, the College introduced the Imperial College PhD Scholarship Scheme offering 50 places for high performing undergraduate or Master's students. There are research group specific programmes: in Cancer*:* CRUK Centre programme, the CRUK/Scottish Power Academic Alliance; Cardiovascular*:* BHF Centre for Research Excellence scheme, NHLI Foundation programme; Computational and systems medicine*:* STRATiGRAD Doctoral Training Programme – MRC/NIHR Phenome Centre, WT ISSF programme in computational medicine and molecular epidemiology; Immunology, Infection and Inflammation*:* WT ISSF inflammation science programme*,* MRC Centre for Molecular Biology and Infection; WT Molecular and Cellular Basis of Infection; Respiratory medicine: MRC/PHE Centre for Environment and Health; MRC-Asthma UK Centre in Allergic Mechanisms of Asthma; MRC COPD PhD training initiative; NHLI Foundation programme; Surgery and Surgical technology: IGHI training programme.

Clinical Programmes

We have developed and maintained a vibrant research culture for our clinical students. The NW Thames Foundation School remains one of the largest programmes in England (116 Academic trainees annually) and remains oversubscribed (1:7, 2013). This year, 48 Imperial students succeeded in obtaining a position on an Academic Foundation programme, the highest of any Medical School. Our Masters courses provide a pipeline of students for PhD programmes, allowing exposure to a specific academic discipline. Over 1200 students are currently studying for a research degree (PhD, MPhil, MD (Res)) or one of the 34 Masters courses within the Faculty. We were awarded 3 prestigious clinical PhD programmes: the WT Clinical PhD Programme, the WT/GSK Translational Medicine and Therapeutics Programme, and the MRC/BRC Chain Florey Fellowships. In addition to the Chain Florey programme, NIHR Imperial BRC has fully or part funded PhDs and CRFs in the following themes: cancer (5), cardiovascular medicine (5), computational and systems medicine (3), diabetes, endocrinology and metabolism (8), infection, immunology and inflammation (14), respiratory medicine (4), surgery and surgical technology (6) and a cross-cutting genetics programmes (6). It is intended that the BRC-funded programmes will be replicated in the Francis Crick Institute. In total, there are more than 300 Clinical Research

Training Fellows (CRTFs) studying for higher degrees, 30% supported by the MRC, WT or NIHR.

We continue to be successful in competing for places on the NIHR Integrated Academic Training Path and have been awarded the second highest number of academic trainees in the UK, with 241 Academic Clinical Fellows (ACFs) and 86 Clinical Lecturers (CLs). All of the current clinical lecturers are returned by Imperial in REF2014. The success of our academic trainees has been outstanding; over 90% of our ACFs have obtained a competitive CRTF to work for a PhD. We were also successful in bidding for HEFCE New Blood Clinical Senior Lecturers (CSLs), with 35 awards (second highest nationally).

d. Income, Infrastructure and Facilities

Since the RAE 2008, the College has invested £325M in building or refurbishing its world-class research facilities, including £148M directly relevant to UoA1. This has realised our strategy of focussing experimental medicine at a re-built and re-furbished Hammersmith Hospital campus.

Under the aegis of the AHSC, joint capital planning has provided the infrastructure necessary to align our biomedical research with clinical services. The key example is the ICTEM, a c£70M new build AHSC flagship centre for research and education serving as a nucleus for research activity at the Hammersmith Hospital campus. At the heart of this building is the NIHR/WT Clinical Research Facility (CRF; *Wilkins* [Director], £10.9M over 5 years) which occupies 1200m^2 with two wards for clinical research, including phase I trials. Facilities in ICTEM include a level III gene therapy suite suitable for ex-vivo cell transfection; fully equipped physiological and metabolic suites for regulated food intake studies; dedicated research PET-CT and PET-MRI imaging and full 5-day in-patient facilities for complex pharmaco-kinetic/dynamic studies. The ICHNT Tissue Bank has been extended to facilitate collection and access of biological samples.

We have relocated the molecular target discovery component of the Cancer theme to ICTEM, aligned to expansion of phase I cancer trials capacity in the CRF. We have also relocated all of discovery Cardiovascular Sciences from South Kensington, RBHNT, and St Mary's to ICTEM supported by the BHF (£6M capital support), in parallel to relocation of all tertiary clinical cardiology to Hammersmith Hospital. The MRC 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. This creates an environment in which activity can range and integrate from model organisms to the patient in the clinic and can extend from single cells to whole body translational studies in one single facility.

Further aligned developments include the MRC/NIHR National Phenome Centre on the Hammersmith and South Kensington campuses in partnership with KCL, and the Imperial BRC Clinical Phenotyping Centre with analytical technology companies which provide high throughput, quality controlled analytical capacity for large-scale metabolic research. The Phenome Centre is equipped with 49 Mass Spectoscopes and 13 high-field NMR for high through-put diagnostic and discovery biomarker research, with an automated LIMS system capable of dealing with 10^6 samples. Support from the instrument manufacturers, Waters plc and Bruker plc, have allowed duplicate machines for training to be installed. We believe that this equipment, a £25M investment in total, represents the largest assembly of 'state of the art' spectroscopic equipment for this purpose in the world.

We launched the UK CRC fully-accredited ICTU in 2010. Further support is provided by the Research Design Service London, part of the NIHR infrastructure and the AHSC Statistical Advisory Service, which provides statistical consulting services and training in statistics and statistical software. The College invested £17M to establish, in 2013, the Imperial College Clinical Imaging Facility housing both PET and MRI facilities and provides support for interdisciplinary research, integrating physical, biological and medical sciences. The College has invested £3.7M in small (£10-50K) clinical research equipment and £11.5M in equipment >£50K.

The NIHR Imperial BRC has provided infrastructure support on the Hammersmith campus for: the molecular pathology laboratory (£2M Next Generation Sequencing facility); the Imperial BioBank (£2M freezer facility); the imaging and fluorescence-activated cell sorting facility (£1M) and the Cancer PET tracer research facilities (£2M).

The NIHR Imperial BRC is a partner in the pan-BRC BioResource, contributing 44,000 subjects, and we chair the BioResource Infection and Immunology sub-group. We also partner the NIHR pan-BRC Health Informatics Consortium (NHIC) which is developing linked IT for research in five

clinical areas across the 5 BRC NHS Trusts. The NIHR has also provided capital funding to support surgical robotics (Hamlyn Centre, jointly with Faculty of Engineering, £2M).

Cancer: Comprehensive Cancer Imaging Centre (CCIC; *Aboagye* [Director]), funded by CRUK, EPSRC, MRC and the DoH, is an internationally leading centre focused on discovery and development of novel imaging biomarkers, particularly PET ligands; NIHR funded an NMR system through the BRC (£1M). The Imperial Experimental Cancer Medicine Centre (ECMC; *Brown, Seckl* [co-Directors]), funded by CRUK and the DoH is developing novel imaging, biomarker and therapeutic approaches for cancer, with a particular focus on reversing drug resistance and aiding personalised treatments. The centre, based at our Hammersmith Hospital site, provides technical and research nurse support for translational studies. Other areas of expertise in the centre include metabolomics and epigenetics, and tissue banking is conducted to underpin biomarker research. Imperial CRUK Centre (*Coombes* [Director]) was launched and renewed during the REF period, providing a centre dedicated to cancer surgery, cancer imaging and drug discovery. The centre provides a unique platform for cross-disciplinary academic research and training in oncology within both ICHNT and the College. The centre integrates core biological cancer expertise with surgical technology, imaging, engineering, chemistry, computing and physics, and through the development of clinical trials, evaluates the safety and feasibility of new technologies by assessing early and medium-term patient outcomes, including quality of life measurements. Ovarian Cancer Action Research Centre (*Gabra* [Director]) is a partnership of Imperial, the Royal Marsden Hospital and ICR that focuses on laboratory and clinical research into the genetic and molecular changes that lead to ovarian cancer to further ways of detecting, treating and preventing the disease.

Cardiovascular Medicine: The College partners the RBHNT to host one of four national NIHR Cardiovascular BRUs (*Pennell* [Director]). The NIHR Cardiovascular BRU has invested £5M, jointly with the NHLI Foundation, to create a 3T research cardiac MRI centre at the Brompton campus incorporating a next-generation sequencing facility and a cardiac BioBank, for deep phenotyping. The major research areas of interest are: advanced imaging, genetics and genomics, aorta and aortic valve, complex coronary artery disease, advanced heart failure, adult congenital heart disease. The £9M BHF Centre for Research Excellence award (*Schneider* [Director]) bringing cardiovascular and biophysical sciences together in joint projects and has stimulated further funding e.g. £1.1M from the EPRSC to the NHLI and Dept of Physics Photonics team to develop for clinical application a prototype system to measure redox status of flavoproteins and NADH in the beating heart by label-free autofluorescence lifetime metrology; to Bioengineering toward a bespoke high-throughput RNAi platform led to a £1.2M Sinergia grant from the Swiss National Science Foundation. The International Centre for Circulatory Health (*Sever* [Director]) investigates new treatments and new prevention strategies for cardiovascular disease. The team have coordinated some of the largest clinical trials ever carried out on the subject of pulmonary hypertension, heart disease and stroke. Two Leducq awards underpin the genomic studies: Leducq Transatlantic Network of Excellence with Harvard for cardiac metabolism (*Aitman* [European Coordinator], 2006-11, $6M) and Leducq Transatlantic Network of Excellence with Harvard/Cornell for cardiomyopathy (*Cook* [European Coordinator], 2011-15, $6M).

Computational and Systems Medicine: In addition to the MRC/NIHR National Phenome Centre, the Computational and Systems medicine group has two other major laboratory infrastructure complexes serving the group (the metabolic spectroscopy application laboratory for biofluid/tissue analysis [South Kensington] and the Imperial Clinical Phenotyping Centre and Surgical Metabolomics lab, the first in the world to be integrated into a hospital setting, at St Mary's Hospital for patient journey phenotyping, supported by the Imperial NIHR BRC; this assembly builds on the Waters Centre of Innovation status.

Diabetes and Endocrinology: We have recently established the Imperial Diabetes Research Consortium, bringing together the broad, world class expertise across the translational pathway. Work spans genomics, epigenetics, cell biology, animal models and clinical research including the development of an artificial pancreas. With Oxford we host the NIHR CRN National Diabetes Research Network (*Johnson* [Chair]).

Infection, Immunology and Inflammation: The MRC CMBI (*Holden* [Director]) uses multidisciplinary approaches and advanced techniques to study bacterial infections at atomic, cellular and whole organism levels, with the aim of finding ways of developing new antibiotics, combating antibiotic resistance and developing effective vaccines. The Centre collaborates extensively with Imperial College-associated hospitals, industry and centres of research excellence

with complementary expertise to achieve this goal. UK CRC CIPM (*Friedland, Holmes* [co-Directors]) is tackling the issue of healthcare acquired infection via a multidisciplinary approach that includes organisational research, social marketing, epidemiology, laboratory-based programmes and education, involving both local hospital trusts and PHE. In addition, we host the Imperial WT Trust Centre for Global Health Research (*Levin* [Director]) which aims to translate advances in research into major diseases such as tuberculosis, malaria and HIV as well as non-communicable diseases. The Wellcome Centre provides a base at Imperial to support the careers and research of fellows at all levels of training who wish to carry out work in the field of global health research. Under the AHSC, we host the National Centre for Human Retrovirology (*Taylor* [Director]) which coordinates research and provides National services for patients with human T-cell leukaemia virus (HTLV) infection; the Jefferiss Trust HIV Clinical Trials Unit (*Winston* [Director]) which undertakes early clinical trials on HIV drugs and vaccines, and the Imperial International HIV Trials unit, responsible for managing the international phase III programmes including the Microbicide Development Programme, DART, SPARTAC, UKHVC and the AfrEVacc and TaMoVac vaccine trials in East and South Africa; these trials have made or changed treatment guidelines internationally (see cases studies).

We founded the Centre for Complement and Inflammation Research to set up the infrastructure to provide comprehensive 'complotyping' of patients from the UK and beyond, funded by the WT, Arthritis Research UK, and Kidney Research UK. CCIR expertise includes *in vivo* experimental model systems, renal pathology, the immunology of autoimmunity and complement genetics. The Centre interfaces with the Imperial AHSC Lupus Centre to drive translational aspects of immunology and inflammation programmes. The Robert Hesketh Hepatology Clinical Research Facility has a DNA and tissue bank, linked with clinical data from several thousand patients in HEP-Base database.

Respiratory Medicine: The MRC/Asthma UK Centre in Allergic Mechanisms of Asthma (*Johnson* [Director]) is a collaboration between ICL and KCL to advance the understanding of asthma at system, cellular and molecular levels, and to inform the development of new, effective and targeted treatments. The MRC/PHE Centre for Environment and Health was established in 2009 as collaboration between ICL and KCL. The work ranges from investigating the levels and sources of environmental impacts, from nanoparticles to bio-aerosols, through to mapping their extent. It encompasses investigating the effects of these factors on individuals through to exploring effects on populations and their relationships with disease. The College partners the RBHNT to host one of three national NIHR Respiratory BRUs (*Alton* [Director]), with focus on chronic lung disease and long term aim to increase the number of new products (therapeutic agents, devices or biomarkers) entering phase I and II clinical trials for advanced lung disease including for example gene therapy studies in cystic fibrosis. The Imperial Clinical Respiratory Research Unit (*Hansel* [Director]) was jointly established by ICHNT and the WT Centre for Respiratory Infection. The unit's focus is on biomarkers for the measurement and profiling of inflammation, infection and repair, conducted by systematic study of blood and respiratory samples to characterise processes with integrated genomic, transcriptomic and proteomic techniques.

Surgery and Surgical Technology: Focusing on technological innovation, with a strong emphasis on clinical translation and direct patient benefit, the Hamlyn Centre for Robotic Surgery (*Darzi*, Yang [co-Directors]) is at the forefront of research in imaging, sensing and robotics. Within the Hamlyn Centre, we have established the Robotic Assisted Microsurgery Laboratory, a joint initiative between ICHNT, the College, the Wolfson Foundation (£3M), NIHR (£2M) and the Helen Hamlyn Trust (£10M). This is the UK's first robotic assisted microsurgery laboratory with a clear focus on technological innovation, direct clinical translation and patient benefit. Key clinical translation of the technology approaches includes gastrointestinal and intra-luminal surgery; fetal and neonatal robotic assisted surgery; natural orifice transluminal endoscopic surgery; and minimally invasive cardiovascular intervention. The Hamlyn Centre is housed on three sites: the underpinning research and development hub at the South Kensington campus, the pre-clinical imaging suite at Northwick Park, and clinical research, simulation and training facilities within the Surgical Innovation Centre at St Mary's Hospital. The Centre equipment includes 4 da Vinci robots (Intuitive Surgical >£8M) for both clinical and research purposes. The Hamlyn Centre has recently received £4M capital grant from EPSRC for a robotics micro-engineering facility and equipment from Karl Storz (£1.5M). The Surgical Innovation Centre is an integrated facility where leading clinical, research and education work takes place under one roof, leading to uptake of innovation

for the direct benefit of patients. The Centre for Patient Safety and Service Quality (CPSSQ) is a multidisciplinary research centre, bringing together a wide range of clinical and scientific disciplines including surgery, medicine, pharmacology and psychology, working together to improve patient safety and the quality of healthcare services. The centre is a partnership between the College and ICHNT, funded by NIHR and is one of only two such centres in the UK. The CPSSQ includes: the Clinical Safety Research Unit, the Dr Foster Unit, the UK CRC CIPM and the Centre for Medication Safety and Service Quality. We have recently been awarded an NIHR Diagnostics Evaluation Centre to study and evaluate point-of-care diagnostics. The Women's Health Research Centre coordinates experimental medicine and translational studies in reproductive and obstetric medicine with a focus on preterm birth and female urinary disorders.

The College's Endowment has as its primary objective the building of an enduring asset base and unfettered income flow for the long-term development of the College. An example of the investments the Endowment enables us to make is the new 23 acre campus in White City known as Imperial West. The centrepiece of this campus will be a new £150M Research and Translation Hub, a 42,000m^2 facility providing high-specification, multi-disciplinary research and incubator space for 1,000 engineers, biomedical scientists and physical scientists who will collaborate with global industrial business and higher education partners in an environment that fosters translation and commercialisation. Within this Hub, the College and commercial partners such as HuaWei will create a centre focusing on data science to harness the latest scientific and technological breakthroughs around big data and translate them into real world applications.

The College also continues to invest in on-going maintenance, spending more than £11M in a capital plant replacement programme during the period 2009-2012. The College provides an extensive range of ICT infrastructure to support research. Significant examples include a very high bandwidth connection to the Janet network to allow data transfers to and from UK, European and international research establishments, which is fundamental in supporting research collaboration with external academic and commercial partners. In addition to this, the centrally managed High Performance Computing service provides 'big data' research groups with access to several computer-intensive architectures, including large shared memory and massively parallel systems. The College has invested £2M in the past four years introducing new strategies and infrastructure to reduce the College's carbon footprint. The College has achieved an EcoCampus 'Bronze Award' status and is close to completing the 'Silver Award'; we recently achieved a universities Highly Commended 'Green Gown Award' and won the Carbon reduction category at the S-Lab awards.

Research facilities and facilities for research students

As part of our refurbishment and rebuilding, we have created dedicated break-out space for graduate students on each floor of the Commonwealth Building and ICTEM (both Hammersmith campus). On each campus, we have created dedicated workbench and computer facilities for graduate students, refurbished the libraries at Hammersmith and St Mary's (£2M, 2012) and up-dated the sports facilities, including a new central swimming pool/gym complex at South Kensington (£5M, 2010). Graduate housing has been built on the Imperial West campus (2012), in addition to the graduate housing on DuCane Rd serving the Hammersmith campus (2008). Significant capital investments for student facilities include the Wolfson Education Centre (Hammersmith Campus, £12M, 2009) as well as refurbishment of the Commonwealth Building (Hammersmith Campus) and Charing Cross teaching and student interaction spaces.

All of our externally funded centres of excellence have research training as cornerstone of their missions and consequently provide foci for bespoke training programmes and dedicated resources to support students linked to our Doctoral Training Accounts and Centre for Doctoral Training. For example, there is dedicated tutorial space in the Imperial International training facility for short courses and for the STRATIGRAD doctoral training programme, where academic tutorials and student social functions are held. We have also established a Facilities Directory which details research facilities and equipment across Imperial. It was created to provide a searchable listing of research facilities and equipment, to enable collaboration and improve efficiency and utilisation of existing equipment and facilities.

Provide evidence of cross-HEI shared or collaborative use of research infrastructure

Four of our MRC Centres are collaborations with KCL, three of which are currently directed by Imperial academics: the MRC/Asthma UK Centre for Allergic Mechanisms (*Johnston*), the

MRC/NIHR National Phenome Centre (*Nicholson*), the MRC/PHE Centre for Environment and Health (Elliott [UoA2]) and the MRC Centre for the Developing Brain (Edwards, ex-Imperial, KCL since 2012). The Centre for Systems Oncology and Innovation is joint with the ICR, as is the Ovarian Cancer Action Centre. As an embedded MRC Institute, the CSC and College share use of imaging, next generation sequencing and animal house facilities as well as the transgenic and embryonic stem cell laboratory. The COPD-MAP project is a collaboration between Imperial, Nottingham, Birmingham, Leicester and UCL to undertake research into COPD, funded by the MRC and ABPI to advance new therapeutic targets. The Cystic Fibrosis Consortium is a long-standing collaboration between Imperial, Oxford and Edinburgh to develop gene therapy for patients with cystic fibrosis and undertake the necessary clinical trials.

Imperial is a partner in the new Francis Crick Institute which is currently auditing equipment needs in the Institute and the three HEIs, with a view to shared access to major technology platforms. The London Centre for Nanotechnology, jointly established between Imperial and UCL, uses shared equipment to develop novel diagnostics, materials and devices. Imperial works closely with the MRC Clinical Trials Unit, now at UCL, with 12 current collaborative programmes.

Through the NIHR BRC Directors group we have established extensive collaborations across the five major BRCs at Imperial, Oxford, Cambridge, UCL and KCL. In particular, we have a jointly administered BioResource of healthy, genotyped subjects with consent to recall by genotype, using a common protocol and consent across all five BRCs, under a single steering committee. The BRC Bio-Resource has expanded to include four sub-themes of neuroscience, cardiovascular, rare diseases and inflammation/infection. Joint projects such as CHERUB, an HIV eradication study, uses a common protocol across all 5 BRCs in order to access specialised laboratory facilities together with access to highly phenotyped patients, with a single BioBank (at KCL) of consented and accessible samples. The BRC Health Informatics programme (NHIC) will use shared IT in order to access routinely collected clinical information for research across the five BRC Trusts.

The most vivid example of collaborative use of a shared infrastructure is Imanova, an innovative pan-London centre for imaging sciences and their application to drug and diagnostic development, focussing particularly on novel PET imaging as a key technology for translational research providing not only novel diagnostic approaches but also the tools to create surrogate markers of efficacy for proof of concept studies. The Global Medical Excellence Cluster worked together to establish Imanova as an independent entity, jointly owned by the MRC, IC, KCL and UCL.

The pan-London AHSC group, London Life Sciences, brings the three HEIs at Imperial, UCL and KCL together with the Trusts, NHS London and the Greater London Authority (GLA) in order to set health strategy across London. All three London AHSCs and the Francis Crick Institute will work with the GLA to build MedCity, building on the health and research capacity of London to advance wealth generation.

Internationally, Imperial has a major collaboration with Nanyang Technological University (NTU), Singapore, and has jointly created a new medical school, the Lee Kong Chian (LKC) School of Medicine, which admitted the first tranche of 90 students in Q3, 2013. A MoU for research collaboration between Imperial College and NTU was signed in 2013, with jointly funded projects to commence in 2014 in metabolic medicine, medical stratification and microbiome genotyping. All LKC academic staff have honorary appointments at Imperial, with three research active LKC staff holding full Imperial appointments.

We have also major research programmes in Qatar – on surgical robotics and the creation of the Qatar BioBank commenced in 2011, the latter closely coordinated alongside the Imperial AHSC BioBank and utilising common, specialised software. A joint clinical initiative in Abu Dhabi, the Imperial College Clinical Diabetes Centre, links Imperial expertise in metabolic medicine to addressing clinical need in the Gulf, with developing research opportunities.

Imperial has received substantial contributions in kind in relation to the establishment of our major international centres of excellence. The creation of the MRC/NIHR National Phenome Centre and NIHR Imperial BRC Clinical Phenotyping Centre led to the large donation of NMR (Bruker BioSpin, £4M) and mass spectrometry (Waters Corporation, £5M) equipment; GSK donated MRI and PET for the preclinical imaging facilities at the Hammersmith campus (£1M); the BHF supported equipping the research angiography suite, linked to the BHF centre of excellence at Hammersmith; the Sowerby Foundation supported of the IGHI (£1M). The MRC funded the provision of MRI equipment in the Clinical Imaging Facility at the Hammersmith (£1M). The NIHR capital infrastructure fund supported MR imaging in ICTEM (£3M); PET chemistry equipment

(£1M); an NIHR/BRC FACS and confocal microscopy facility (£1.1M) and £3M in support of enhanced molecular pathology including next generation sequencing.

The Wolfson Foundation supported the refurbishment of the Wolfson lecture theatre and the development of the Robotic Microsurgery Laboratory in the Surgical Innovation Centre; IAVI contributed £1M to the refurbishment of the Imperial Human Immunology Laboratory and the Eranda Foundation to the refurbishment of the surgical simulation centre. Karl Storz Ltd, ORzone and the London Deanery have provided over £1.5M worth equipment for surgical clinical skills research and training facilities.

Our industrial partners have funded or co-funded academic posts and long-term secondments from industry at Imperial. Since 2008, GSK have supported Solari on long-term secondment to the MRC/Asthma UK Asthma Centre and Pfizer supported the secondment of *Kirkham* to work on new targets for asthma, with two further secondments in Q4 2013; Novartis are part funding *Xu* in vaccine design and development; Westwick was appointed from Novartis and Waters have funded two senior academic posts (Want and Wilson) in relation to the MRC/NIHR National Phenome Centre (and two senior post-docs) and both Bruker and Waters have allocated an engineer each of the Phenome Centre. Waters, Merck, Servier and Bruker also contribute the equivalent of £1M annually to support the StratiGrad PhD programme in computational medicine.

Policy and practice in relation to research governance

We have used the AHSC to streamline our research management structure; a Joint Research Office (JRO) was established in 2008, and acts as a one-stop shop for all clinical research across the College and ICHNT. The JRO provides advice and assistance with: creating and submitting an application, contract negotiation, setting up an award, the financial management of a project through its lifetime and the reconciliation and closure of the grant at the end of the project. Within the JRO, the Joint Research Compliance Office aims to help researchers in the College and ICHNT undertaking clinical studies to meet the requirements of research governance and to ensure we fulfil the legal, ethical and scientific obligations to the healthcare research process. We were the first UK university to introduce InForm Integrated Trials Management System, a comprehensive service to support the collection, management and analysis of data from clinical trials. A purpose-designed database, DOCUMAS, has been introduced as a single repository of all clinical study information across the AHSC. Recently, a purpose-designed database, DOCUMAS, has been introduced as a single repository of all clinical study information across the AHSC. The successful harmonisation of research support in the JRO has facilitated a 20% increase in patient participation rates in trials since 2011-12.

e. Collaboration or contribution to the discipline or research base:

Imperial researchers make a full national and international contribution to clinical medicine. Examples of some of our extensive contributions to the research base and collaborations are listed below; these are not exhaustive. Returned within UoA1 are included: the UK's Chief Medical Adviser (*Donaldson*, 1998-2010), a Life Peer (*Darzi*), a Knight Commander of the British Empire (*Darzi*), three Knights Bachelor of the British Empire (*Bloom, Donaldson, Yacoub*), a Knight First Class, Finland (*Huhtaniemi*), two Commanders of the British Empire (*Atkin, Spratt*), eight Fellows of the Royal Society (*Barnes, Holden, Darzi, Ingham, Simpson, Spratt,* Williams*, Yacoub*), 41 Fellows of the Academy of Medical Sciences (*Aboagye, Aitman, Alton, Angelini, Bangham, Barnes, Bloom, Botto, Cook, Coombes, Darzi, Evans, Farrell, Fisher, Franks, Friedland, Goldman, Haskard, Holden, Huhtaniemi, Johnston, Kay, Kelleher, Kooner, Kroll, Lalvani, Levin, Nicholson, Openshaw, Parker, Pusey, Schneider, Scott, Screaton, Simpson, Spratt, Thomas, Warner,* Williams*, Withers, Young*), four EMBO Fellows (*Aragon, Fisher, Merkenschlager, Parker*), 13 NIHR Senior Investigators (*Apperley, Barnes, Bush, Chung, Darzi, Di Mario, Fox, Lalvani, Levin, Pennell, Pusey, Vincent, Wood*), 13 Wellcome Trust Investigators (*Allday, Aragon, Bangham, Ferrer, Grundling, Holden, Merkenschlager, Moffatt, Rankin, Rutter, Screaton, Strid, Wigneshweraraj*), one Fellow of the Institute of Medicine (*Darzi*), and a member of EPSRC Council (*Darzi).*

Examples of participation in the peer-review process in the REF period include:

BHF: Project Grants Committee (*Kohl, Leiper*), Chair and Programmes Committee (*Harding*), Fellowships Committee (*Wilkins*, [Chair]), Council (*Wilkins*);

CRUK: New Agents Committee (*Aboagye, Brown* [Vice-Chair]), Biomarker & Imaging Discovery

& Development Committee (*Brown* [Vice-Chair]), Science Committee (*Coombes*), Clinical Trials Advisory and Awards Committee (*Gabra*);

ERC: FP7 Expert Evaluators (*Chayen, Cook, Randi, Schneider*), Synergy Awards Reviewer (*Fisher*), FP7 BMBF German Federal Ministry of Education and Research, Stem Cell Review Panel (*Fisher*), Starter Grant Panel (*Frost, Johnston, Rosenthal, Schneider, Simpson*), Senior Fellowships Board (*Gotch*);

MRC: Non Clinical Training and Career Development Panel (*Ashton-Rickardt, Carling*), Developmental Pathway Funding Scheme Panel (*Bloom*), Infection and Immunity Board (*Bangham*) Strategy Board (*Fisher*), Clinical Training and Career Development Panel (*Freidland*), Population and Systems Medicine Board (*Harding*, *Haskard*, *Rutter, Withers*), Council (*Schneider*), Discipline Hopping Awards Panel (*Screaton*);

NIHR: Efficacy and Mechanism Evaluation Committee (*Bloom*), Research for Innovation, Speculation and Creativity Panel (*Hanna*), BRC/BRU Panel (Kelleher), Academic Training Awards Panel (*Pusey* [Deputy Chair]);

Royal Society: Dorothy Hodgkin Fellowship panel (*Simpson*), International Travelling Fellowships panel (Lloyd), and Newton International Fellowship Committee (*Rutter*);

Wellcome Trust: Basic Science Interview Panel (*Barclay, Screaton*), Clinical Interview Panel (*Botto, Kelleher*), India Alliance Clinical and Public Health Research Committee (*Lalvani* [a joint venture with Government of India]), Immunology and Infectious Disease Funding Committee (*Lloyd, Openshaw*), Physiology and Health and Disease Panel (*Schneider*);

Other examples include Action Research (*Bennett*), Tenovus Scientific Advisory Board (*Bevan*), AMS Starter Grants for Clinical Lecturers Panel (*Botto*), Breast Cancer Research Trust (*Coombes* [Trustee]), Leukaemia and Lymphoma Research Committee (*Farrell* [Chairman]), EMBO Science and Society Panel Member (*Fisher*), Breast Cancer Campaign Scientific Advisory Board (*Flanagan*), HEFCE Clinical Senior Lecturer Selection Panel (*Friedland*), NC3Rs Grant Award Panel (*Gooderham*), Lister Institute (*Holden, Kroll)*, Arthritis UK Programme Committee (Kelleher), Scottish Senior Fellowship Panel (Kelleher), EDCTP TB Vaccines Funding Committee (*Lalvani* [Chair]) and Senior Fellowships Programme (*Lalvani* [Vice-Chair]), Health Review Board Ireland Clinician Scientists Awards Committee (*Lalvani*), LUPUS UK Peer Review Panel (*Lightstone*), Novo Nordisk Research Foundation (*Johnston*, [Chairman of Grant Board]), Diabetes UK Research Committee (*Johnston* [Intermittent Chair], *Rutter*), 2004 Marie Curie Cancer Care Executive Board (*O'Hare*), Pancreatic Cancer UK Scientific Advisory Board (*O'Hare*), European Foundation for the Study of Diabetes Panel (*Rutter*), Juvenile Diabetes Research Foundation International (*Rutter* [Medical Sciences Review Committee]), Association for International Cancer Research Grants Committee (*Seckl*), Pancreatic Research Charity (*Seckl* [Vice Chairman]), Government of South Korea (*Simpson*, [Science Funding Advisor]), UK Food Standards Agency Project Review Committee (*Strid*), British Liver Trust Research Committee (*Taylor-Robinson*), The Cholangiocarcinoma Charity (*Taylor-Robinson*), Prostate Cancer UK (*Waxman* [Board]), and Sir Jules Thorn Charitable Trust Medical Committee (*Withers*).

Examples of editorships and membership of major editorial boards, include:

European Respiratory Journal (*Adcock, Belvisi*), PLoS One (*Athersuch, Bundy, Costa-Pereira, Franks, Kassiotis, Ma, Wilkinson*), PLoS Medicine (*Barnes, Evans*), American Journal of Respiratory and Critical Care Medicine (*Barnes*), Endocrinology (*Bassett, Dhillo*), Science (*Batista, Holden*), Nature Immunology and Cell Biology (*Batista),* EMBO Journal (*Batista, Reis e Sousa*), Am J Obs Gynae (*Bennett*), BJOG (*Bennett*), Cell Metabolism (*Berggren*), Diabetes (*Berggren*), JAIDS (*Bower*), Thorax (*Bush* [Editor] *Cullinan, Lloyd* [Deputy Editors]), European Heart Journal (*Camm, Cleland, Di Mario, Gatzoulis, Pennell, Serruys, Swedberg*), FEBS Journal (*Carling*), Journal of Biological Chemistry (*Carling*), Journal of the American College of Cardiology (*Cleland, Pennell, Serruys*), Heart (*Cowie, Pennell, Sever*), Journal of Thrombosis and Haemostasis (*Crawley, Lane, Luken*), Annals of Surgery (*Darzi*), Journal of the American Medical Association (*Darzi),* International Journal of Cardiology (*Francis, Gatzoulis*), Journal of Clinical Endocrinology & Metabolism (*Franks*), AIDS (*Gregson*), BMC Family Practice (*Harris*), Nature Communications (*Holmes*), Science Translational Medicine (*Holmes*); Developmental Cell (*Ingham*), Nucleic Acids Research (*Lenhard*), Journal of Experimental Medicine (*Lloyd, Merkenschlager, O'Garra*), Mucosal Immunology (*Lloyd, Shattock*), Journal of Proteome Research (*Nicholson* [Associate Editor]), Molecular Systems Biology (*Nicholson*), British Journal of Anaesthesia (*Ma*), Immunology

(*O'Garra*), J Am Soc Nephrology (*Pusey*), Asia Pacific Journal of Clinical Oncology (*Sharma*), World Journal of Hepatology (*Sharma*), Journal of Clinical Oncology (*Stebbing*), Cancer Research (*Seckl*), Journal of Infectious Diseases (*Stebbing),* Oncogene (*Stebbing* [Deputy Editor]), European Journal of Heart Failure (Swedberg [Editor in Chief]), British Journal of Hospital Medicine (*Taylor*); Open Opthamology Journal (*Taylor*) Journal of Hepatology (*Taylor-Robinson*), Journal of Neuroendocrinology (*Williams*), and Infection and Immunity (*Young*).

Examples of fellowships, named lectures and awards received by our staff include:

Fellowships: Software Sustainability Institute Fellowship (*Abel*), BHF Intermediate Basic Science Research Fellowship (*Ahnstrom, Luken, McKinnon, Salles*), MRC Clinician Scientist Fellowship (*Antoniades, Armstrong-James*), RSC Tom West Analytical Fellowship (*Athersuch*), Kay Kendall Leukaemia JRF (*Auner*), BHF Intermediate Clinical Fellowship (*Babu-Narayan*), ERC Marie Curie Career Integration Grant (*Bajorek*), Master Fellow of the American College of Chest Physicians (Barnes), ERC Starting Grant (*Bartke*), NIHR Intermediate Fellowship (Bewick, Dhillo, Drumwright, Usmani), Kay Kendall Leukaemia Intermediate Research Fellowship (*Bond*), Honorary Fellow of the American College of Surgeons (*Darzi*), Honorary Fellow National Institute of Clinical Excellence (*Darzi*), Honorary Doctorate Royal College of Surgeons, Ireland (*Darzi*), Honorary Fellowship of the Royal Academy of Engineering (*Darzi*), German Research Foundation Postdoctoral Fellowship (*Dorner*), Leukaemia & Lymphoma Research Bennett Fellowship (*Feldhahn*), Wellcome Trust Senior Research Fellowship (*Lalvani, Lloyd, Pickering, Wilkinson, Williams*), NIHR Clinician Scientist Fellowship (*Gordon, Jayasena, Kenny, Manisty, Roy*), Wellcome Trust/Royal Society Sir Henry Dale Fellowship (*Harker*), ERC Marie Curie Intraeuropean Fellowship for Career Development (*Hodson*), AMA/Wellcome Trust Starter Grant for Clinical Lecturers (*Jayasena*), MRC New Investigator (*Johnson*), NIHR Senior Fellowship (Kampmann), Wellcome Trust Public Engagement Fellowship (Kneebone), Chinese Academy of Sciences Wang-Kuan-Cheng Research Fellowship (*Li*), ERC Marie Curie International Incoming Fellowship (*MacIntyre*), Wellcome Trust Clinical Research Training Fellowship (*Natanek*), Honorary Fellowship of the Metabolomics Society (*Nicholson*), Diabetes Research and Wellness Foundation Non-clinical Research Fellowship (*Pullen*), Wellcome Trust Principal Fellowship (*Spratt*), Brain Tumour Research Campaign Grassini Fellowship (*Syed*), NIHR Career Development Fellowship (*Taylor*), and BHF JRF (*Whinnett*).

Named Lectures and Awards: Best Translational Research Innovation Award (Medical Futures Innovation, *Alton*), ESICM ECCRN Basic Science Award (*Antoniades*), American Heart Association Outstanding Research Award in Pediatric Cardiology (*Babu-Narayan*), Mackenzie Medal (*Camm*), Women of Outstanding Achievement for Innovation and Entrepreneurship Award (*Chayen*), Investigator of the Year of the Life Sciences Awards (Chayen), Jacob Churg Award (*Cook* [Renal Pathology Society]), Bisset Hawkins Trust Medal, (*Donaldson* [Royal College of Physicians]), Hong Kong Academy of Medicine Keynote (*Donnelly*), Women of Outstanding Achievement in SET (*Fisher*), Feldberg Prize (*Franks*), Alberto Sols Senior Investigator Award for Basic Research (*Ferrer* [Spanish Society of Diabetes]*),* Mary Jane Kugel Award (Juvenile Diabetes Research Foundation, *Ferrer*), Takreem Award for Science and Technology (*Habib*), Women of the Future Awards 'Mentor of the Year' (*Higham*), Great Allergist Award (*Kay* [American Academy of Allergy]), Conway Medal of the Royal Academy of Medicine in Ireland (*Kelleher*), British Pharmacology Society Bain Memorial Award (*Kirkby*), Weber-Parkes Medal for Advances in Tuberculosis Prevention (*Lalvani* [Royal Society of Physicians]), Distinguished Career Award International Society on Thrombosis and Haemostasis (*Lane*), British Society of Cardiovascular Research Young Investigator award Basic Science (*Lyon*), Inaugural Bernard and Joan Marshall Young Investigator award (*Lyon*), Raffety Prize in Cardiovascular Sciences Medical Research Society (*Lyon*), Outstanding Contribution Award from the Chinese Society of Anesthesiology (*Ma*), British Society for Echocardiography Annual Research Award (*Manisty*), EMBO Young Investigator (*Miguel-Aliaga*), AstraZeneca Women in Pharmacology (*Mitchell*), Robert Zhong Award for Surgical Technology (*Nicholson*), Semelweiss Budapest Award (*Nicholson*), Royal Society of Chemistry Thephalous Redwood Lectureship (*Nicholson*), MRC Keynote Lecturer (*Nicholson* [Society of Toxicology]), Chanock Award (*Openshaw*), Croonian Lecture (*Openshaw*), Women in the City Medicine Award (*Regan*), BHF Research Excellence Award (*Rutter*), Dorothy Hodgkin Lecture (*Rutter* [Diabetes UK]). Royal Society Wolfson Merit award (*Rutter, Schneider*), Translational Research Innovation Award for Cardiology (Medical Futures Awards, *Schneider*),

International Society of Hypertension AstraZeneca Award (*Sever*), Garrod Medal, (*Spratt* [British Society for Antimicrobial Chemotherapy]*),* GlaxoSmithKline International Member of the Year Award, (*Spratt* [American Society for Microbiology]), European Society of Cardiology Silver Medal (*Steg*), Gustav Nylin Lecture (*Steg*), State of the Art Lecture International Society for Thomobosis and Haemostatis (*Steg*), Hardiman-Redon Prize (*Strid* [CRUK]), Paul Dudley White Lecture (Swedberg [American Heart Association]), Sheila Sherlock Award, Royal College of Physicians (*Taylor Robinson*), European Thyroid Association Merck Serono Prize (*Williams*), and Society for Endocrinology Medal (*Williams*).

Our researchers are officers of learned societies. Examples include:

European Society for Blood and Marrow Transplantation (*Apperley* [President]), Royal Society Chemistry Downland Committee (*Athersuch*), AMS (*Botto* [Sectional Committee Two], Kelleher [Sectional Committee Four), Renal Pathology Society (*Cook* [Board of Directors]), British Society of Heart Failure (*Cowie* [Chairman]), European Society of Cardiology (*Cowie* [Board Member and Chair of Education Committee]), International Society for Quality in Health Care (*Darzi* [Expert Panel]), Society for Endocrinology (*Dhillo* [Science Committee], *Williams* [Treasurer and Council Member]), British Society for Allergy and Clinical Immunology (*Durham* [President]), Metabolomics Society (*Ebbels* [Board of Directors]), PCOS UK (*Franks* [Chair of Executive Committee]), Royal Society of Medicine, Endocrinology & Diabetes Section (*Franks* [President and Chairman of Council]), British Infection Society (*Friedland* [President]), Royal Society of Medicine (*Ghaem-Maghami* [Secretary of Section of Obstetrics and Gynaecology]), Royal College of Obstetricians and Gynaecologists (*Ghaem-Maghami* [Scientific Advisory Committee]), European Society for Engineering and Medicine (*Habib* [Director]), International Association of Surgeons and Gastroenterologists (*Habib* [Board Member]), International Society of Cancer Gene Therapy (*Habib* [President]), Association of Laparoscopic Surgeon of Great Britain and Ireland (*Hanna* [Research Director]), European Association of Endoscopic Surgeons (*Hanna* [General Secretary]), European Society of Endocrinology (*Huhtaniemi* [Executive Committee]), British Thoracic Society (*Johnston* [Council Member]), Federation of European Academies of Medicine (Kelleher [Vice President]), Royal College of Physicians Academic (*Lalvani* [Medicine Committee]), UK Renal Association (*Lightstone* [Executive Committee]), Chinese Life Scientists Society in the UK (*Li*); Royal College of Paediatrics & Child Health (*Modi* [Vice President]), British Pharmacological Society (*Rankin* [Education Committee]), RCOG (*Regan* [Council Member]), International Society for the Study of Trophoblastic Disease (*Seckl* [President]), American Society for Microbiology/ICAAC (*Sriskhandan* [Committee Member]), European Society of Cardiology (*Steg* [Chair, Research Committee]), French Society of Cardiology (*Steg* [Board Member]), British Society for Immunology (*Strid* [Programme Committee]), Royal College of Physicians of London (*Taylor-Robinson* [Associate International Director]), British Association for Lung Research (*Tetley* [President]), British Thoracic Society (*Tetley* [Scientific Committee]), Society of Biology (*Thorley* [Biomedical Sciences and Public Engagement Committees]), European Association for Study of the Liver (*Thursz* [Secretary-General]), British Thyroid Association (*Williams* [President]), European Thyroid Association (*Williams* [Executive Committee]), and World Thyroid Foundation (*Williams* [Advisory Committee]).

We make a significant contribution to external bodies (NHS, Government, Industry), for example:

NHS/Government: Joint NCRI Prostate Cancer Collaborative (*Bevan*), NCRI Biomarkers and Imaging Clinical Studies Group (*Brown* [Chair]), CLRN (Cleland [National Lead for Heart Failure]) Royal Air Force (*Cobb* [Civilian Advisor in Orthopaedics]), NW Thames Comprehensive Local Clinical Network (*Cowie* [Chairman]), UK Business Ambassador (*Darzi*), World Economic Forum Health Agenda Council (*Darzi* [Chair]), National Research Ethics Committee (*Drumright*), NHS England Society for Endocrinology (*Franks* [Clinical and Nominations Committees, Wellbeing of Women Research Advisory Committee]), DoH Tuberculosis Reference Group (*Friedland*), MRC/NIHR Public Health Infection Science Strategy Group (*Friedland* [Chair]), Royal College of Physicians HAI Working Group (Chair, [*Friedland*]), NCRI Informatics Initiative Scientific and Technical Advisory Panel (*Gabra*), NICE Health Technologies Assessment Committee (*Ghaem-Maghami*), MHRA (*Gooderham* [PIP Breast Implants Toxicology Task Force and Preclinical Product Assessment Panel]), English Laparoscopic Cancer Surgery Training Programme (*Hanna* [National Educational and Academic Lead]). All Party Parliamentary Group on Global Health (*Harris* [External Expert]), Governmental Advisory Committee on Antimicrobial Resistance and

Healthcare Associated Infection (*Holmes*), UK Diabetes Research Network (*Johnston* [Director]), Council of Healthcare Professionals at Diabetes UK (*Johnston* [co-Chair]), Meningitis Research Trust (*Kroll* [Medical Director]), United Kingdom Haemophilia Centres Doctors Organisation (*Laffan*, [Secretary]), National Patient Safety Agency/Royal College of Paediatrics & Child Health (*Modi* [Chair, Safer Practice in Neonatal Care]), National Advisory Committee, Centre for Maternal and Child Health Enquiries (*Modi* [Deputy Chair]), NCRI Translational Research Board (*O'Hare*), DoH Scientific Advisory Group in Emergencies (*Openshaw*), NICE Interventions Committee (*Regan*), International Federation of Gynaecology and Obstetrics (*Regan* [Chair]), Global HIV Vaccine Enterprise Scientific Committee (*Shattock*), National HTLV Register (*Taylor* [Chairman]), British Standards Institute (*Thorley* [Nanotechnologies Committee]), Kings Fund Inquiry into Safety of Maternity Services (*Vincent*), Parliamentary Health Select Committee on Patient Safety (*Vincent* [Expert Adviser]), Commission for Health Improvement (*Vincent*, [Commissioner]), Swiss National Patient Safety Foundation (*Vincent* [Scientific Advisory Board]), NHS National Screening Committee (*Waxman*), WHO Mathematical Modelling Committee (*White*), UK Government Scientific Advisory Group for Emergencies and Scientific Pandemic Influenza (*White* [Advisory Committee]), WHO Informal Network for Mathematical Modelling (White), President Obama Consultation Global Health Initiative (*White*).

Industry: Ariad (*Apperley* [Scientific Advisory Board {SAB}]), Bristol Myers Squibb (*Apperley* [SAB]), Novo Nordisk (*Apperley, Kampmann, Lyon*), Soligenix (*Apperley* [SAB]), Creabilis (*Anand* [SAB]), Aerocrine (*Barnes* [SAB]), Altana (*Barnes* [SAB]), Argenta (*Barnes* [SAB]), AstraZeneca (*Barnes* [SAB]), Boehringer Ingelheim (*Barnes* [European Advisory Board]), Millennium Pharmaceuticals (*Barnes* [SAB]), Almirall (*Belvisi* [SAB]), GlaxoSmithKline (*Belvisi* [SAB]), Glenmark (*Belvisi* [SAB]), Infirst (*Belvisi* [SAB]), Novartis (*Belvisi, Pennell* [SAB]; *Cleland* [International Advisory Board]), Argenta Discovery Ltd (*Bloom* [SAB]), Bayer (*Cleland* [International Advisory Board]; *Laffan, Pennell* [SAB]), Phillips (*Cleland* [International Advisory Board]); *Laffan, Pennell* [SAB]), Boston Scientific (*Cowie* [European Advisory Board]), GE Healthcare (Darzi [Board]), Merck (Durham [SAB]), Cell Aegis (*Fox* [SAB]), Vitabiotics (*Lalvani* [SAB]), Antibe Therapeutics (*Mitchell* [SAB]), ApoPharma (*Pennell* [SAB]), Shire (Pennell [Chairman, Data Safety and Monitoring Committee]) and Cell Medica (*Pusey* [SAB]).

Examples of effective academic collaboration are extensive and include:

European Consortia: The College is the third most successful institution in Europe for FP7 awards. UoA1 examples include: *Thursz* leads the PROLIFICA programme (CP-SICA) studying the prevention of liver fibrosis*; Levin* leads the EUCLIDS programme (CP-L) studying the genetic basis of susceptibility to invasive meningococcal disease; *Openshaw* leads the PREPARE programme (CP), a platform for building pan-European preparedness against pandemic Influenza; *Shattock* led the EUROPRISE consortium addressing HIV vaccine and microbicide product development and is co-leader of the CUTHIVAV trans-cutaneous delivery of novel vaccines group. *Gabra* directs the EUTOC ovarian cancer action, with *Ghaem-Maghami* serving on the translational research committee; *Moffatt* and Cookson (UoA2) lead the pan-European GABRIEL consortium studying genetic and environmental influences on susceptibility to asthma; *Woods* led the EURACTION cardiovascular prevention consortium;
Tudor-Williams is a committee member of the European AIDS Treatment Network; *Pickering* secretary of the European Complement Network; *Kampmann* is a member of the EDCTP Scientific Advisory Committee. *Chung, Adcock* are steering committee members of the UBIOPRED IMI consortium addressing new targets for severe asthma.
International consortia: in addition to the Lee Kong Chian Medical School with NTU, Singapore, the Abu Dhabi Imperial Diabetes Centre and the Qatar Imperial Biobank and Surgical technology centres, we have formal MOUs with the MD Anderson Cancer Center, Texas, USA (*Coombes*); the Asan Medical centre, Seoul South Korea (*Coombes*); the Qatar National Cancer Research Strategy Committee (*Brown, Darzi*); the Beijing Genomics Institute (*Nicholson*); the British Council/MRC India Diabetes Initiative (*Johnston*); the International Human Epigenome Consortium (*Fisher*, Steering Committee), the NIAID, NIH, USA Immune Tolerance Network (*Durham*, Exec and Chair, Allergy Consortium); *Young* is on the board of the Tuberculosis Vaccine Initiative PPP.