Institution: St George's, University of London

Unit of Assessment: A1 Clinical Medicine

a. Overview

St George's, University of London is the UK's only dedicated medical and healthcare university, and occupies a single shared site with a large, thousand-bed, multi-specialty teaching hospital located in an area of south-west London characterised by high social and ethnic diversity. Serving a population of 1.3 million, St George's has developed an extensive and highly effective series of networks that together provide access to a population of 3.4 million for tertiary care.

In RAE2008 St George's returned 111 FTE staff in six Units of Assessment (UoA). An additional 20.7 FTE were returned in a joint submission with Kingston University in two UoAs. In that exercise St George's strategy was an inclusive return that reflected the broad range of research conducted in the organisation, but which inevitably masked several areas of outstanding research quality. Following the outcome of that exercise St George's has undertaken a comprehensive re-examination of its research strategy as described below. The current return in REF2014 differs significantly from that in 2008 in that we have shifted the focus onto areas of internationally leading excellence. In this exercise we are submitting 56.5 FTE (61 staff) in two UoAs. There is no joint return with Kingston University. This reflects a strategic development in the University that has recently culminated in the establishment of three research institutes – Cardiovascular and Cell Sciences, Infection and Immunity, and Population Health. The first two major groupings are returned in UoA1 while Population Health is returned in UoA2.

Central to the development of this research strategy has been:-

- Maximising the interaction between the University and St George's NHS Trust,
- Enhancing interaction between clinicians, clinical academics and biomedical scientists,
- Providing an environment that nurtures and develops scientists throughout their career,
- Growing and developing our multiple academic, industrial and health-related partnerships at a local and global level,
- Focusing investment into established areas of strength to create a focused, responsive, patient-centred translational research environment.

b. Research Strategy

Following the last RAE St George's undertook a detailed review of its research strategy. This culminated in the 2010-2015 Research Strategy described in the 2010 Strategic Plan which established a greater degree of research focus with the establishment of three administrative Divisions hosting six Research Centres. Research activity that lacked critical mass was retained within the Divisional structure outside of Research Centres.

This plan called for the establishment of a new full-time post of Dean of Research and Enterprise, to which an external appointment was made in April 2012. Following a further review of research performance, a further iteration of the research strategy was introduced in 2013 with the creation of three Research Institutes and a single Education Institute. Each Institute holds administrative responsibility and will direct and develop research in the core areas of Cardiovascular and Cell Sciences, Infection and Immunity, and Population Health. The Education Institute facilitates greater professionalism and research in medical education and provides a mechanism to develop, recognise and reward excellence in education.

Our return to UoA1 aligns precisely with this structure and includes the activity of researchers in the Institute of Cardiovascular and Cell Sciences and the Institute of Infection and Immunity. Over this REF cycle there has been a period of revitalisation within this UoA with the retirement (Child, Nussey, Griffin, Malik) or relocation (Crosby, Halliday, Lewis, Markus, Shattock) of several research active professorial staff, and the recruitment of younger faculty at an earlier career stage.

About half the staff returned in this UoA were not employed by St George's at the start of the REF period and about a quarter are early career researchers. We view this regeneration very positively although it has inevitably had adverse effects on research income.

The achievements for the research groups being returned in this UoA are described below:

Infection and Immunity

The emergence of novel microbial pathogens and resistance to existing therapeutic strategies poses an enormous global challenge. St Georges has had a longstanding strength in these areas developed initially under Lambert and subsequently by Griffin, who recently retired. We have developed a strategy to build strength in depth in areas of international-level excellence – specifically: novel therapeutics and vaccinology and in global health, while developing a select number of new initiatives, prompted by new challenges and technological advances. Each group's activity is summarised below. Importantly, we will maintain and grow the capacity to implement research in all our chosen areas from basic science and product development levels through to clinical trials. The significant impact of Infection & Immunity research is reflected in three of the impact case studies submitted to this UoA.

The creation of a pathology hub located at St George's and serving three SW London hospital NHS Trusts (St George's, Kingston, and Croydon), provides an outstanding opportunity to track large numbers of samples and linked clinical data. This potential has been recognised by the recent award of a major NIHR CLARHC grant (Sept 2013, value £17M including matched funding) to a consortium of King's Healthcare Partners and St George's, with St George's (Sharland) leading on the infection theme. This opportunity facilitates our ability to develop diagnostics of sexually transmitted infections (STIs) and TB, as well as to work on the epidemiology of gram-negative infections with a view to development of rapid diagnostics and resistance testing for these infections.

Novel Therapeutics and Vaccinology - **Coates**, who recently co-authored a major commissioned article in *Lancet Infectious Disease* on antibiotic resistance and the need for global solutions, is working towards the development of novel antimicrobial agents that will kill non-replicating bacteria in partnership with Helperby Therapeutics. He has developed a novel agent for topical staphylococcal infection, which is currently in clinical development. **Butcher** has similar goals for mycobacteria, defining the metabolic state of persisting TB organisms that cause relapses and prolong treatment. Development of novel therapeutics has been strengthened by the appointment of **Hilpert**, who brings expertise in anti-microbial peptide design and synthesis and has active research projects with anti-pseudomonal, anti-tuberculous, and antifungal peptides. **Fisher** has continued his work in collaboration with a number of pharma exploiting an in-depth understanding of the structure-function relationships of the gyrase and topoisomerase IV drug targets in *Strep. pneumoniae* and other pathogens, using the first X-ray structures of the DNA-topoisomerase complexes with quinolones. (**Impact Case Study**).

Ma and colleagues work on the design, engineering and manufacturing of recombinant protein pharmaceuticals using plant biotechnology. They are world leaders in the production of antibodies for therapy of Infectious Diseases and have successfully completed a pioneering first-in-human phase I trial of a plant-derived antibody for the prevention of mucosal infection by HIV. A further European (ERC) grant of €3.5 million will enable development of a pipeline of plant-expressed antibody-based therapeutics, with rabies post-exposure prophylaxis as an important first target. Delivery of plant-derived antibodies to prevent and treat nosocomial infectious disease will also be an important aim of the group for the next REF period.

Robinson has made exciting progress in the development of novel inhaled small molecule inhibitors to block dust mite allergy with the support of a Wellcome Seeding Drug Discovery Programme. This work is the subject of discussion with major pharma and publication has been embargoed for commercial reasons, but is likely to be reported in the next REF period.

Heath leads the Vaccine institute, one of only three similar facilities for first-in-human vaccine

studies in the UK. This group has a portfolio of academic and commercial paediatric studies in progress including a Premature Vaccine Study (HPA), of 200 preterm infants in 10 neonatal units. Following the successful introduction of maternal vaccination against pertussis, he is leading the development of maternal vaccination against neonatal group B streptococcal infection. Phase I clinical trials examining mucosal routes of immunization for HIV antigens are part of an international collaboration to determine the safety and efficacy of this route of delivery, and are part of ongoing work with **Cranage** and **Hu** on HIV and mucosal immunology (see below). In other areas a phase III *C. difficile* toxoid vaccine study will start later this year.

Global Health - St George's partners the London School of Hygiene and Tropical Medicine (LSHTM) in the Wellcome Trust Bloomsbury Centre for Global Health Research. **Harrison** was co-PI together with researchers from the LSHTM on the successful renewal of the Centre in 2012 and serves on its Steering group, with **Krishna** and **Bicanic** on the Policy group. This collaboration gives St George's PIs access to a larger critical mass of PIs involved in international work, and multiple opportunities for scientific exchange and collaborations. Our research in global health includes:-

- *Molecular parasitology.* **Krishna** has characterised transporter proteins of *Plasmodium sp*. to identify new targets for chemotherapy (e.g. the hexose transporter), and has defined the mechanism of action of artemisinins. Clinical studies in Gabon will optimise artesunate dose regimens for treatment of severe malaria, and for non-artemisinin combinations for uncomplicated malaria. **Cooper** (Wellcome Trust Senior Fellow) investigates the impact of early exposure to geohelminth parasites (e.g. *Ascaris lumbricoides*) on immune responses to standard childhood vaccines and the development of allergic sensitization, eczema, and asthma in a cohort of 2,400 newborns in Ecuador. He is also investigating the effects of migration and urbanisation on development of atopy/asthma in urban and rural school children in Ecuador.

- *Mycobacterial disease*. The InterTB Group (Jindani, Mitchison, **Harrison, Checkley**) have recently completed a major phase III trial, RIFAQUIN (EDCTP/MRC funded, value €6M) of shortened and intermittent chemotherapy for pulmonary tuberculosis in southern African countries – using a moxifloxacin for isoniazid substitution and high dose rifapentine in the continuation phase. A once weekly regimen in the continuation phase was shown to be as effective as the standard 6 month regimen and could be used as first-line treatment in settings and circumstances where directly observed therapy is considered important. A phase II study of high dose rifampicin has also been completed, and leads to a phase III trial to test a 4 month regimen using high dose rifampicin. (MRC – under consideration). If effective, a 4 month regimen would significantly enhance TB control efforts worldwide.

- *Cryptococcal meningitis*. Studies in Thailand, South Africa, Uganda, and Malawi have used rate of clearance of infection as a novel tool to assess treatment regimens (**Harrison**, **Bicanic**, **Loyse**). The results have had major influence on IDSA, African, and WHO guidelines for treatment of this commonly fatal complication of HIV. In addition, optimized regimens based on phase II studies are now being tested in a major multinational, phase III trial funded by the MRC (£2.6M). The feasibility of preventing clinical disease through screening for cryptococcal antigen in HIV infected patients and pre-emptive antifungal therapy is being tested in prospective studies. A novel point-of-care immunodiagnostic test has been developed with industrial partners that will facilitate screening in resource-limited settings. **Bicanic** is using the extensive collection of isolates and clinical data to explore the influence of pathogen diversity on outcome. (**Impact Case Study**).

During this REF period we have also developed specific new initiatives that build on areas of strength and developing technologies including:

Molecular Diagnostics - A major initiative around the discovery and development of rapid point-of-care diagnostics and drug resistance profiling builds on the strengths of the pathogen genomics

group and has been underpinned by major grants to Sadiq (MRC £5.3M), **Krishna** (EU - €3.9M), and **Butcher** (MRC), around diagnostics for STIs, malaria, and tuberculosis, respectively. **Krishna** has worked closely with an SME, QuantuMDx, to develop a hand-held rapid DNA sequencing device. This partnership has received substantial funding from the EU for point-of-care malaria drug resistance diagnosis, and from the TSB for TB diagnostics (£2M). Butcher has received Gates Foundation funding (£2M) for development of a *S.pneumoniae* genotype diagnostic. **Planche**, working initially with **Krishna**, has refined and developed diagnostic testing for *C.difficile* (**Impact Case Study**). **Lindsay** has made major contributions to understanding MRSA pathogenicity, and collaborates with **Baines** whose research examines the metabolic status of the normal and inflamed bronchial epithelium.

Viral immunology - HIV mucosal immunology and vaccinology has been the focus of **Cranage** who has developed novel approaches to HIV immunisation using, in part, non-human primate models, while **Hu** (recently appointed to a substantive senior lectureship in conjunction with Institute of Virology, Wuhan, China) has explored HIV antigenicity and the immune response. Dalgleish has recently received a £1M award from GLOBVAC for therapeutic HIV vaccine development. **Macallan** has focused on developing an understanding of the biology of T-cells in HIV and other viral infection. **Goodbourn** has maintained a highly effective collaboration with Randall in Dundee in elucidating the role of innate immunity to viral infection and plans to expand this work with his Wellcome Trust Senior Investigator Award; in support of this development we have appointed **Strang**, who joins the group from Harvard Medical School, as a non-clinical lecturer in CMV cell biology and immunology.

Cardiovascular and Cell Sciences

Cardiac rhythm disturbances, the pathogenesis and prevention of degenerative vascular disease and its ramifications in angina and stroke provide some of the major challenges confronting clinicians. Research during the REF period has focused on understanding the pathogenesis of these disorders and developing new diagnostic and therapeutic solutions.

Our work benefits from, and is intimately entwined with, the extensive clinical activity in St George's Healthcare NHS Trust. Our translational research potential has been advanced with the recent recruitment of **Prasad** from the Mayo Clinic to a new Chair of Interventional Cardiology as he brings important research expertise which will expand research in this area. The Trust also has one of the UK's largest aortic aneurysm clinical practices, which has stimulated considerable research in therapeutic approaches under the leadership of Thompson. The group supports **Holt**, a new blood Senior Lecturer whose research has focused on aneurysm repair outcomes, and has important links with the basic science work of **Cockerill**.

The new *Cardiovascular and Cell Sciences Institute* will develop this research focus by substantially expanding our basic science support to provide a critical mass at all levels. Research in this area falls into four main groups:

***Cardiac Arrhythmia Research* -** There has been a long history of research into cardiac rhythm disorders – mainly atrial fibrillation - at St George's under the leadership of **Camm**. He has continued his research into the management of atrial fibrillation with major contributions to key clinical trials of new agents. Future research in this area will be maintained through successful succession planning and the career development of **Sharma** and **Behr**.

The team's work has included the application of novel ECG analyses and imaging techniques in Brugada syndrome and arrhythmogenic right ventricular cardiomyopathy for diagnosis and risk stratification. Several novel ECG methods are the subject of a patent application. The group also participated in the discovery of novel genetic loci in long-QT syndrome (QT-IGC consortium), and in Brugada syndrome using GWAS techniques. The demographics, clinical features and genetics of victims of unexplained sudden death - the Sudden Arrhythmic Death Syndrome (SADS) has been the focus of work by **Behr** and **Sharma** supported by **Papadakis**, (an academic Clinical Lecturer). Post-mortem next generation sequencing and novel histopathological and

immunostaining techniques, in part funded by a BHF special project grant (£1M), have been accomplished in collaboration with the cardiac pathology expertise of Sheppard at the Royal Brompton Hospital, who has recently been recruited to expand and support the team at St George's. The group has been further strengthened by the recruitment of **He**, who has a special interest in development of novel cardiac MRI techniques, and who interacts closely with our MRI physics group (**Barrick** and Howe – see below). Furthermore, **Behr** together with Sheppard and Ackerman (Mayo Clinic) are evaluating genetic and cardiovascular risk in Sudden Infant Death Syndrome (SIDS) and the role for molecular autopsy and evaluation of families in identifying heritable risk, based on a large collection of 800 British cases of SIDS with coroner and pathologist collaboration.

Participation in regular intensive exercise is associated with electrical and structural modifications that may overlap with morphologically mild phenotypic expressions of primary cardiomyopathies. **Sharma** runs the 'Athlete's Heart' programme in the UK and has established an international reputation for this. In collaboration with the English Institute of Sport, British Rugby League and Rugby Union, Lawn Tennis Association and the Football Association, he has characterised cardiovascular adaptation in athletes and examined the impact of ethnicity, demonstrating that black athletes exhibit a higher prevalence of electrical repolarisation changes and a greater left ventricular hypertrophy compared with white European athletes.

Pathogenesis, Prevention and Treatment of Coronary Artery Disease **-** The risk factors underlying the development of atherosclerosis, and coronary disease in particular, are the focus of **Ray** and **Seshasai**, (an academic Clinical Lecturer). They have reported findings arising from the 'Emerging Risk Factors' study, which brought together data from 121 prospective studies involving over 1.27million subjects on blood glucose control and on the potentially adverse actions of statin therapy. Furthermore, their work on the lack of benefit of aspirin prophylaxis in individuals without recognized coronary disease has had substantial impact on the application of this form of prophylaxis.

Kaski's group have identified inflammatory pathogenic mechanisms leading to microvascular angina and explored the role of the adaptive immune response in the pathogenesis of atherosclerosis and acute coronary syndrome. They have shown that methods to target the specific T cell subsets that are increased in acute coronary syndrome ($CD4^+$ $CD28^{null}$ cells) may be of benefit in treating acute coronary syndrome.

Degenerative Vascular Disease **-** The opportunities presented by institutional restructuring provide great opportunities to bring together scientists working in cardiovascular and cerebrovascular disease with our placental biologists (Whitley and **Cartwright**), cell biologists (**Bennett**, **Shaw**) and developmental biologists (**Brown**) to create a formidable cardiovascular sciences research group. This has been bolstered by our recent recruitment of **Carter** as Professor of Endothelial Cell Biology.

Cockerill's work, involving close interactions with our vascular surgeons, has focused on understanding the cellular and molecular mechanisms of degenerative vascular disease, specifically abdominal aortic aneurysm. She has used analysis of human biopsy material from end-stage aneurysmal lesions and animal models of aneurysmal disease to identify potential targets for disease treatment. Hainsworth has focused on pathological mechanisms involved in stroke and cerebral small vessel disease including an analysis of HDAC9 – a genetic risk identified by Markus, (who recently departed to take up a Chair in Cambridge). These studies benefit from close interaction with our stroke clinicians (**Lovelock**) and MRI physicists including **Barrick** and Howe who have major interests in vascular dementia and stroke. The clinical ramifications of both vascular dementia and Alzheimer's disease are key interests of **Garrard**. **Papadopoulos** has made major contributions to understanding the role of aquaporin-4 in neuromyelitis optica.

Cartwright, working with Whitley has explored the mechanisms of vascular remodelling in the placenta and the role of immunological factors in this process, in part in collaboration with **Kaski**. **Carter**, recently recruited from NIMR, Mill Hill, has made key contributions to the understanding of

endothelial cell exocytosis using a range of cell biological and cell imaging techniques. Added value is achieved with the cell biological expertise of **Bennett**, a leading authority on cell senescence and **Shaw**, who contributes her research on chromatin modification in scarring and wound healing supported by a recent MRC MICA award. Furthermore, the longstanding expertise in ion channel biology at St George's has been advanced through the work of **Greenwood** who researches on the functions of potassium channels in the vasculature and their role in hypertension with BHF and MRC support.

***Cell Biology and Functional Genetics* -** St George's NHS Trust hosts an internationally respected Clinical Genetics Department with wide ranging expertise in a range of syndromes and single gene disorders. Specific areas of clinical excellence surround lymphoedema, Noonan's syndrome, Marfan's syndrome and other aortic diseases, and inherited cardiac rhythm disorders. These clinical resources have supported extensive gene discovery research either at St Georges or in a variety of international collaborations. Of particular note in this respect is the work of **Jeffrey** and **Ostergaard** who have identified several genes that underlie lymphoedema syndromes. Looking forward, it is clear that it will be necessary to develop our expertise and resources in cell biology and functional genetic analysis, building on the expertise of **Bennett**, **Shaw** and **Brown** and recruiting **Clark**, (from QMUL), **Carter** (from NIMR), **Osborn** (from UCL) with zebrafish expertise, and MacKay (from QMUL) who brings iPS cell technology. These researchers will provide added value to the skills of several others including **Rice**, who with Mason researches the basis of polycystic ovary syndrome, and **Brown** who has made major contributions to the understanding of left-right patterning in cardiac development.

c People, including:

i. Staffing strategy and staff development

For the majority of this REF period St George's has categorised staff into Research (committed to up to 10% time teaching), Teaching & Research (committed to up to 40% time teaching) and Teaching & Scholarship. With the development of a more focused research and educational strategy, staff in the research institutes will be able to devote significantly more time to research with a flexible teaching commitment. Newly appointed staff at all grades often have no teaching commitments. The success and sustainability of such a policy depends on effective performance management of research staff combined with a supportive mentoring strategy. The institute structure provides an effective framework for this. St George's operates a comprehensive annual Personal Review process that has excellent compliance.

Equality and diversity - SGUL has developed a Single Equality Scheme three-year action plan for all protected groups. 94% of staff are accredited by our innovative experiential Equality & Diversity training programme which the GMC recently commended as an area of good practice in their institutional review. We have separate Equality & Diversity web pages for each protected group, which supports inclusive practice in the workplace. We are a Stonewall Diversity Champion. We have an active Athena SWAN Action Group and are currently awaiting the outcome of our bronze status application. In line with Equality Challenge Unit advice, we have embedded consultation mechanisms to provide regular opportunities for the institution to consult with all sections of its staff. We provide a breast-feeding room and a multi-faith and quiet contemplation room. Selected staff have been trained to identify and assess individuals at risk of domestic abuse, stalking and honour based violence.

Integration of clinical academics and NHS-employed staff - Substantial progress has been made in integration of research strategies between the St George's Healthcare NHS Trust and the University. This has been driven from the highest level in the two organisations with the development of a joint research strategy. The Dean of Research sits on the Trust Research Strategy group and participates in activities such as awarding of research PAs and research sabbaticals to NHS staff (see below), while the Associate Medical Director for Research sits on the University Research Strategy Committee. Research Institutes incorporate NHS clinicians working in relevant areas to provide a pathway for closer involvement between academics and clinical staff. Clinical staff participate in Institute activities including research awaydays and strategy planning.

Multiple examples of this interaction have been provided in section (b).

Effective development and support of the research work of staff - Continuous staff development is a prominent feature of employment at St George's with a wide range of transferrable skill training opportunities available. A recent development has been the Emerging Leaders programme, an intensive individual and group-training programme that runs over a 12 month cycle that has been very well received by its participants who in several cases have demonstrated an enhanced career trajectory.

St George's is committed to the principles outlined in the Concordat to support the career development of researchers. Following the launch of the Concordat in 2008 three policy decisions were introduced:

i) Appointment of an Associate Dean to focus on Career Development of Research Staff.
ii) Introduction of a part-time, portfolio-based Postgraduate Certificate in Research Skills bringing together various core and optional development opportunities and supported by an individual mentor. This course has been commended by its external examiners and by Vitae as an example of excellent practice in researcher career development.
iii) Implementation of a requirement that all staff with management responsibility for research engage positively with researcher's skills and career development, including regular probation, review and performance management meetings.

St George's has been awarded the European HR Excellence in Research award.

Research career development - St George's gives high priority to developing its early career researchers. This is in recognition of the fact that many of our current mid-grade and senior academic staff were recruited as ECRs, and development of their careers has institutional as well as individual benefits.

Over this REF period St George's has held two cycles of ECR recruitments on a 5 year "tenure-track" lecturer basis with research productivity being the main determinant of tenure. Appointees are provided with a supervisor and line manager, and a mentor – normally from the same sector, but not directly involved in the appointee's research, and are regarded positively in internal competitions such as the Equipment Users Committee, Wellcome Institutional Strategic Support Grant, Enterprise and Innovation funding awards and PhD studentships.

St George's celebrates its research with an annual Research Day, which includes internal and external speakers and a vibrant poster session, and to which staff, students, alumni and other associated individuals are invited. The Jenner Day focuses on infection and immunity research developments with a combination of internal and external speakers.

Developing a research ethos amongst clinicians is embedded in our undergraduate educational activities, and we are proud to have one of the most active and well-established student research societies in the UK. This society, known as SUPRA, recruits around 200 new members with each annual intake of students (across all courses, but mainly focused on medicine). SUPRA arranges a wide variety of activities including visiting lectures, workshops, and an annual International Student Conference. In 2013 this conference, funded in part by the Academy of Medical Sciences, attracted over 100 students from 5 countries, the majority of whom presented their work.

Developing the early research careers of clinical academics can be extremely challenging given the frequent high demands on their time from the clinical service. To date a single individual has co-ordinated these activities with some success, but we now plan to expand this role with the establishment of a "Clinical Academy". St George's supports a relatively large number of clinical academics undertaking higher degrees, both MD(Res) and PhD, funded by the main external funders (MRC, Wellcome Trust, BHF) as well as various pharmaceutical companies.

ii. Research students

In this REF period St George's has placed increased emphasis on Research Student Supervision. We have created a post of Associate Dean for Research Degrees who chairs the Research Degrees Committee. All students are assigned to a trained Lead supervisor who will have a proven track record in successful supervision and timely completion. Early career researchers are mentored through the process within supervisor teams. Student progress is monitored in regular reports so that problems can be addressed as early as possible. Our postgraduate coordinator system was cited by QAA as an example of good practice in their "outcomes from Institutional audit: 2009-2011 Postgraduate Research Students".

All research students have the use of our Graduate Centre and participate in our in-house skills programme based on the RCUK Joint skills statement and which is aligned with Vitae Researcher Development Framework. Students also have access to further training at neighbouring institutions and all SGUL staff development workshops. Students participate in our residential research degrees summer school shared with Kingston, Royal Holloway and Roehampton Universities and organised by South West London Academic Health and Social Care System (see section (e)).

Our research student body includes a relatively large population of MD(Res) students with a steady stream of new applications via links with the Trust, and a relatively high proportion of overseas students, an area that is likely to expand in the future. There are also a number of students jointly supervised with partner organisations including the Animal Health and Veterinary Laboratories Agency Health Protection Agency, National Institute for Biological Standards and Control, BBSRC Pirbright Institute and the National Physical Laboratory. St George's has held 3 CASE awards during this REF period (2 MRC, 1 BBSRC) as well as a number of non-CASE industrial partnership awards. Three students are holders of patents derived from their work during their studentship.

Research students are encouraged to take an active role in public engagement activity and events. Through this they have shared their research in the Royal Society Summer Science exhibition, St George's Community Open Day, at our Spotlight on Science evenings as STEMNET ambassadors, and as part of the Brilliant club scheme becoming involved with local schools.

d. Income, infrastructure and facilities

Income - Staff returned in this UoA all occupy a single large (33,000 m^2) purpose built research building (the Jenner Building). Parts of this building have recently been refurbished with support from HEFCE SRIF (£12M) to a high standard to provide (2000 m^2) of outstanding facilities serving both Infection and Immunity and Cardiovascular and Cell Science groups. In addition to light open plan office, lab and seminar room space, several areas for informal interaction have been constructed. Staff have been extremely positive about this refurbished space which also acts as an effective incentive in recruitment.

Funding for research is derived from a combination of Research Councils, medical research charities and industry. These are managed through a Joint Research and Enterprise Office (JREO) (jointly supported with St George's Healthcare Trust) with separate departments of Research Grants, Governance and Enterprise. Major awards during this REF period include a Wellcome Trust Seeding Drug Discovery award to Robinson (£4.99M) and a Wellcome Trust Senior Investigator award to **Goodbourn**, and ERC award to **Ma** (€3.5 million), , EU FP7 awards to Eder (£1.2M to St Georges), **Ma** (£1.75M to St Georges), **Camm** (€12.0M led by St George's) and **Krishna** (€3.9m led by St Georges), MRC awards to Sadiq (£5.3M), **Harrison** (£2.6M) and a DPFS award to Bax (£3.0M). The TSB has awarded £2M to **Krishna**, the Gates Foundation, £2M to **Butcher**, and Norweigan Research Council (GLOBVAC) £1M to Dalgliesh.

Infrastructure - Research in St George's is managed through the Research Strategy Committee (RSC) which reports directly to the primary executive committee (the Strategic Planning and Resources Committee) chaired by the Principal, and to St George's Council. The RSC has oversight of:-

- **The Joint Research and Enterprise Office**, which is managed and funded jointly with St

George's Healthcare NHS Trust and embraces Research Grants, Governance and Enterprise. This structure has evolved over this REF period with significant institutional investment to provide experienced high quality leadership in each section, reporting to a single JREO Director who reports to the Dean of Research and the Chief Operating Officer.

- **The Equipment Users Committee** (budget £500-600K) considers strategic (institutional), multi-user and single-user bids. The Committee enables the funding of equipment for new staff and supports key equipment maintenance across the Institution.

- **The Institutional Strategic Support Group** oversees expenditure of our Wellcome Institutional Strategic Support funds and matching institutional funds. This includes consideration of applications to the St George's Researcher Development support scheme (providing bridging funding for talented researchers) and the Technician Infrastructure Support Scheme. This has proved an effective resource that has supported important strategic developments in the organisation.

- **The Core Facilities Group** oversees the performance of each of the facilities described in the next section to ensure their financial and operational effectiveness.

Facilities

St George's provides researchers a broad array of technical resources and infrastructure on a single clinical site to support their research. These include:-

- **Biomics** - which provides state of the art genomics, transcriptomics and proteomics mass spectroscopy facilities. These include Illumina Beadchip, qPCR, Ion Torrent NGS and Applied Biosystems 3130 sequencing, and a range of proteomic facilities including LC/MS/MS, MALDI-TOF/TOF & SELDI-TOF mass spectroscopy and laser capture microdissection. The facility is staffed by a team of four highly experienced technical and scientific staff.
- **Imaging** – this core facility provides a technician-supported laboratory with one scanning electron microscope (EM), one transmission EM, two Zeiss confocal microscopes with a wide range of support packages, and several conventional fluorescent microscopes. The recruitment of **Carter** will add several further imaging options including TURF and intravital microscopy.
- **FACS** - A new category 3 laboratory suite intended for HIV immunology work also houses our recently purchased 13-colour Beckman Mo-Flo Cell sorter. A senior technician is employed to manage this and other FACS equipment
- **Biological Research Facility** is a large multifunctional facility supported by a team of 6 trained technical staff providing support for ovine, porcine, rodent, zebrafish, *Xenopus* and *Drosophila* work. Equipment includes oocyte injection equipment for reptiles, fish and mammals, ultrasound and small animal MRI. A major bid for development of porcine models for cardiovascular research including a large animal MRI is currently under consideration.
- **Clinical Research Facility** - run jointly with St George's Healthcare NHS Trust is a custom-built centre that provides physical facilities and nursing and administrative support to facilitate CLRN-adopted and non-CLRN clinical trials. The facility is open for use by university and trust staff, as well as students and other organisations. This is located in proximity to the **Vaccine Institute** (section (b) a unique vaccine trial facility including examination rooms, four observation rooms and a category 2 isolation suite that support a range of adult and paediatric vaccine trials.

e. Collaboration and contribution to the discipline or research base

St George's maintains strong collaborative networks at both an institutional and an individual level. The South West London Academic Health and Social Care System is one such network established in 2009 that links St George's with 12 local NHS Providers and Clinical Commissioning Groups, 6 local authorities and two universities with the aim of improving health and social care for the local population. This is based on a subscription model and has been widely recognised as an

effective model for academic health sciences networks.

St George's holds a Memorandum of Understanding with Kings Health Partners and is a member of the South London AHSN (the Health Innovation Network). This collaborative grouping has recently been awarded a CLAHRC. St George's is also included as a strategic alliance in the Kings AHSC renewal application. Together with Royal Holloway University of London and Kingston University, St George's forms SWAN (the South West Academic Network) that supports collaborative activities between the three universities via project grants and PhD studentships.

In a wider dimension, St George's has a formal link with the London School of Hygiene and Tropical Medicine in the Wellcome Trust Bloomsbury Centre for Global Health. Amongst many other highly effective research collaborations, the Wellcome Trust Senior Investigator Award to **Goodbourn** at St George's and Randall at Dundee University, and the ERC Advanced Grant to **Ma** at St. George's and Fischer at Univ. of Aachen are noteworthy.

Contribution to the discipline

Several members of this return have held positions on national and international review panels during this REF period. These include **Krishna**, (Wellcome Trust/DBT India Alliance panel), **Lindsay** (BBSRC Basic Bioscience Underpinning Health Strategy Advisory Panel), **Ma** (vice chair for the European COST Action on Molecular Farming), **Harrison** (Infectious Diseases Society of America, and Southern African HIV Clinician's Society expert panel member), **Heath** (DoH Joint Committee on Vaccination and Immunisation), **Kaski** (CENIC and IMBIC (Spain) and CONICET (Argentina), Lovell (NC3R panel member and Chair of the Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment) and **Lovelock** (Stroke Association Awards Committee). Griffin, who prior to retirement chaired the Griffin inquiry *E.Coli* O157 outbreak at Godstone farm, has become one of four non-executive members of Public Health England.

Others have active roles in scientific publishing including: **Camm** (Editor-in-Chief: *Clinical Cardiology, EP Europace*) and **Clark** (Editor-in-Chief: *Journal of Endocrinology, Journal of Molecular Endocrinology*). **Bennett** is a member of the editorial Board of *Pigment Cell and Melanoma Research*, and equivalent roles are held by **Butcher** (*Tuberculosis*), **Fisher** (*Biochemical Journal, Antimicrobial Agents and Chemotherapy* and *Journal of Antimicrobial Chemotherapy*), **Kaski** (*European Heart Journal, Cardiovascular Drugs & Therapy*), **Greenwood** (*British Journal of Pharmacology*), Hainsworth (*Clinical Sciences, Frontiers in Analytical and Experimental Pharmacology*), **Heath** (*Current Opinion in Infectious Diseases*) and **Clark** (*Endocrine Connections*).

Leading contributions to learned Societies currently, or during this REF period include:-
Bennett - President, European Cell Senescence Association, **Butcher**, Chair, Acid Fast Club, **Camm** – President, Arrythmia Alliance, Founder and Trustee, Atrial Fibrillation Association, **Kaski** - President, International Society of Cardiovascular Pharmacotherapy, **Ma** - Founding President of the International Society for Molecular Farming. Amongst other notable national and international contributions arising through their research profile **Sharma** is the Medical Director for Virgin London Marathon, cardiologist for the English Institute of Sport, British Rugby League and the British Lawn Tennis Association. In this REF period three members of staff have held Presidencies of a Royal College – Professor Arulkumaran (RCO&G), Professor Hollins (RCPsych) and Dr Patricia Hamilton (RCPCH).