Institution: University of Surrey

Unit of Assessment: UOA 3 Allied Health Professions, Dentistry, Nursing and Pharmacy

a. Overview

The University merged its biosciences, medical, health and social care activities into a single Faculty of Health and Medical Sciences (FHMS) in August 2007. The research aim of this merger was threefold: to promote further integration of our biomedical and nutritional sciences research activity with our clinical research efforts, to embrace the growth of our health and nursing research, and to continue to build critical mass aligned to our biomedical strengths. During the assessment period our department of chemistry, initially part of FHMS, was transferred to the Faculty of Engineering and Physical Sciences in recognition of the research strengths in materials and physical chemistry within the department. In the latter part of the REF assessment period, FHMS saw further development with the establishment of a School of Veterinary Medicine and in 2013 we made the first appointments in this area (2.4 FTEs included in this submission), with a mission and philosophy to develop biomedical and veterinary research within a "one health" concept for human and animal health. For REF 2014, the main thrust of our research is in biomedical and nutritional sciences, and includes emerging translational research from our nursing and healthcare activities.

In RAE 2008 our biomedical research was highly ranked by Allied Health Professions & Studies (UoA12) with 60% of our research rated world-leading or internationally excellent. Since then both the academic departmental structure and the research group matrix has developed substantially and we have appointed ~40 academic staff to increase further the quality and cohesion of our biomedical and health activities. FHMS now has three component Schools: Biosciences & Medicine, Health & Social Care and Veterinary Medicine, which are the academic homes of staff for both research and teaching. Our research structure is embedded in six biomedical and health research groups (listed in section b) representing the research strengths of the Faculty. Staff belong to a home research group representing their main research focus, but this does not preclude their involvement in other groups. This fluidity has been specifically aimed at promoting collaboration as well as multi- and interdisciplinary working across the Faculty, an important feature of our former research thematic structure, presented in RAE 2008. As part of the integration of biomedical and health research, Surrey has a lead role in the Kent, Surrey and Sussex Academic Health Sciences Network established in 2013 which will deliver and sustain the growth of clinical academic groups with NHS and industry partners.

b. Research strategy

Our overarching research strategy since the inception of the Faculty in 2007 has been to further develop our identity as a world-leading centre for basic and translational research underpinning health and medicine, from clinical practice to policy development and implementation. The new development of a School of Veterinary Medicine is also key to our mission of being a world-leading institution for both human and animal health. A 5-year rolling research strategy is updated annually as part of the University planning process, and forms a key driver for justification of new appointments, for realignment of research priorities, as well as providing annual monitoring of research performance and research groupings. The strategy also sets 5-year targets for research in relation to growth of research income and studentships, increased quality of publications and improvement of PhD completion rates. At the individual academic level we have established annual monitoring using a research metric model (R-factors) that provides component metrics for income, publications and studentships (I, P and S-factors). These are computed for income, from grant awards; for publications, from citations, journal impact factor and 5-year H-index; and for studentships, from PhD/MD registration and completion data. Annual review of individual research performance is undertaken at the research group and School level and the annual appraisal system aims to develop staff appropriately to ensure an upward trajectory for our research metrics. Our research group leaders play a key role in assessing the research performance of academic staff, and this assessment feeds into the formal annual appraisal in each School. Since RAE 2008 we have seen growth in all component metrics:

- Mean journal impact factor of research outputs increased from 5.1 to 8.8 with one third of outputs in journals with impact factors >9
- Overall research income/year for RAE 2008 of £5.5 million, increased to £6.1 million/year over the REF period
- Increased research income/ FTE/year from £90K (RAE 2008) to £125K (excluding new appointees in last six months)
- PhD's awarded/year for RAE 2008 of 29/year increased to 32/year in the REF period
- Increase in PhD degrees awarded/ FTE/year compared to RAE from 0.47 to 0.67 (excluding new appointees in last six months)
- PhD student new registrations per year increased from 27 in 2008 to 42 in 2013.

Research plans

In 2012, we reviewed and fully revised our research strategy for 2012-2017 in a planning document entitled "towards REF 2014 and beyond". This plan not only took into account the new elements of UK research assessment, particularly impact, but also set in place a strategy for responding to the increasingly competitive research funding environment. With respect to impact, our recruitment policy for 2012-2017 includes substantial growth of medical, veterinary and other non-medical clinical appointments, which will build on our proven biomedical research strengths and expand and sustain our emerging veterinary and healthcare activities. Many of these appointments will be jointly funded with our NHS and veterinary partners and this, plus an increased use of our Surrey Clinical Research Centre, will grow our translational and applied clinical research to deliver major societal impact. This focus is also reflected in the three nursing impact case studies submitted to the REF that have emanated from our School of Health & Social Care. Our leading role in the Academic Health Sciences Network will ensure that new clinical academic collaborations continue to be established with the NHS and industry, and clinical academic research groups are already developing. We have also aligned growth to the grand challenges that face society with a primary focus on lifelong health and wellbeing. We will grow research in the healthy ageing arena in which we already excel, particularly with respect to the areas of sleep, cardiovascular disease, diabetes and cancer. We have made targeted and successful bids for growing our postgraduate research (PGR) student population including a doctoral training partnership, funded by the BBSRC in the thematic area of food security, aligned to our successful nutrition and human health research, and in collaboration with several other HEIs. In addition, our partnership with the University of Sao Paulo is attracting high quality overseas PGR students as part of the "Science without Borders" initiative funded by the Brazilian government. In the last 12 months the establishment of our School of Veterinary Medicine at Surrey, the first in the South-East of England, provides a growing focus for our research under a "one health" mission. This venture embraces our strong research collaborations with the Animal Health and Veterinary Laboratories Agency, Pirbright Institute, the University of Reading and our global partner at North Carolina State University, a leading US institution in Veterinary Science. In the next 2 years we are investing £45m in our new School of Veterinary Medicine, which will have state of the art clinical skills facilities that will enable us to develop a centre of excellence in livestock health associated with our research activity in biosciences and medicine. This initiative serves a national need for the growth of veterinary research. Appointments in Veterinary Medicine have been made in the last two months of the REF period. Our plan over the next REF period is to integrate our veterinary research activity with our biomedical research, not only in the areas of infectious diseases and systems biology, but also in those human disease areas (e.g. cancer and metabolic disease) where many parallels exist to the veterinary field.

Research groups

Our six research groups are run by group leaders, chosen from our most successful research professors, who are responsible for grant bidding workshops and surgeries, seminar programmes and networking facilitation, as well as providing strategic advice and support for improving the quality and citation of publications and increasing grant income. The groups provide a platform for academic co-operation and interaction, and for promoting interdisciplinary research efforts. These are supported by University initiatives, such as sandpit funding to promote biomedical and health

research interactions. To support the large School management units, group leaders play a significant role in research leadership and mentorship, particularly of junior staff. They appraise research performance of their staff, are involved in staff development, and contribute to decision making for new academic appointments. The strategic direction and main scientific achievements of the groups in the REF period are detailed below:

Cardiovascular & Cancer Studies group.

This group is primarily focused on understanding the complex genomics of cancer and cardiovascular disease and translating this into novel therapeutic interventions. During the assessment period the elucidation of intracellular phosphatase pathways in the pathogenesis of muscle disorders and atrial fibrillation has attracted both Haste and British Heart Foundation funding (£0.8m) **(Fry)**. The development of a human cardiac slice model has also provided a novel platform for research into pharmacological and gene therapy treatments of cardiac diseases **(Camelliti)**. A critical new function for the Adenovirus serotype 5 hexon in mediating liver gene transfer through binding with coagulation factor FX has also been elucidated **(McVey)**. The EU-funded (FP6) PROCARDIS team made significant breakthroughs in understanding distinct genetic loci associated with coronary artery disease and type II diabetes **(Green)**. Separately, demonstration that a combined genotype for two SNPs in the genes for selenoprotein P and superoxide dismutase 2 is associated with double the risk of advanced prostate cancer, suggests that increased dietary selenium levels may benefit these patients **(Green, Rayman)**. Research developing a unique way of targeting HOX gene dysregulation has been evaluated in seven cancer models funded by the Prostate Project (£1.2m) **(Morgan)**. In addition, demonstration that the secretion of engrailed-2 (EN2) in urine may be utilised as a biomarker of prostate and bladder cancer has led to a successful FP7 award exploring biomarkers for bladder cancer (£4.9m), further exploration of EN2 in a national prostate cancer study (PROMIS) and the licensing (Zeus Ltd, USA) of EN2 for commercial development (**Morgan, Pandha)**. Other transcriptomic and proteomic markers used to determine disease stage in prostate cancer have been patented **(Aukim-Hastie)** and biomarkers of chemotherapy response and drug resistance in ovarian cancer have identified epigenetic silencing of genes *PLK2* and $P57^{KIP2}$ as markers of drug resistant disease **(Coley)**. We have also shown enhanced cytotoxicity with oncolytic viruses and radiotherapy in melanoma **(Ajaz)**. We have pioneered work characterizing DNA repair enzymes and highlighted the relevance of these repair systems in protecting against age-related diseases **(Meira)**. Significant advances have been made in the understanding of molecular mechanisms underlying coronary artery disease and the impact of invasive intervention in patients presenting with stable angina and acute coronary syndromes **(Mahmoudi)** as well as identifying the critical role of circulating microparticles in the pathophysiology of metabolic syndrome and septic shock **(Agouni)**. In addition, vertebrobasilar stenosis has been demonstrated to be a predictive marker of early recurrent stroke risk **(Khan)**. We also identified the regulatory mechanism of Nox2 activation, and the redox-regulation of endothelial function in health and disease. This work has led to the patenting of novel NOX-2 inhibitors for many disease conditions (GB20120000725) **(Li).**

Computational & Systems Biology group.

This group applies computational and systems biology approaches to basic research underpinning health and industrial biotechnology. During the assessment period their international reputation in bacterial pathogen genome scale metabolic network (GSMN) modelling led to EraSysBio+/BBSRC funding (£1.2m) coordinated by **Kierzek.** Computer simulations (**Kierzek**) and mathematical modelling (**Rocco**) of stochastic variability in pathogen genetic circuits has provided further insight into pathogen survival strategies and mathematical modelling of gene regulation has also been applied in the context of development (**Rocco**). Systems biology of bacterial pathogens is complemented by systems biology research on the role of translational regulation in innate immunity (**Simmonds**). We have developed novel experimental methods, theoretical approaches and software, including RIP-chip-SRM, a novel experimental method for identification of translational regulation targets **(Gerber)** and differential producibility analysis, a new approach for analysis of transcriptomics data in the context of GSMN modelling (**Kierzek**, **Laing**). In addition, marginalised posterior decoding has been developed as a new algorithm for assessing uncertainty of sequence homology inference (**Rocco**). SurreyFBA has become the leading software in computer simulation of whole-cell metabolism (**Kierzek**), and has been recognised by a recent

BBSRC TRDF award for its further development (**Kierzek**, **Plant**). In the context of industrial biotechnology, the group has applied GSMN simulation to the optimisation of *Streptomyces coelicolor* metabolism for industrial fermentation of antibiotics and other drugs (**Smith, Kierzek**). With BBSRC and industry-funded translational research in Industrial Biotechnology (BRIC and IBTI programmes £0.5m) the combination of fermentation technologies with genome scale metabolic network modeling and functional genomics has developed strains and bioprocesses applied in pharmaceutical production and biofuels (**Smith**, **Kierzek**). These methodologies have also been applied to questions related to human health. In particular, through participation in the FP6 funded (£0.2m) NucSys network (**Plant**) and BBSRC-funded research (£0.6m) focus on the systems biology of nuclear receptors has elucidated their role in liver lipid loading **(Moore, Plant, Kierzek)**. This project has resulted in the first dynamic simulation of molecular interaction networks describing gene regulation, signalling and whole-cell metabolism in human cells. Computational and systems approaches have also been applied to clinical samples from a BBSRC-funded (£1.1m) interdisciplinary programme on the genetic basis of sleep and cognitive performance (**Smith**, **Laing, Dijk**). Finally, ground-breaking work on the fitness landscape of small RNA regulatory networks **(Jimenez)** is now being used for rational design of RNA regulatory networks in the growing area of Synthetic Biology.

Infectious Diseases group.

The aim of this research group is to understand the interactions between host and pathogen with the goal of designing new therapies and control strategies including vaccines, drugs and molecular diagnostics. During the assessment period, a systems-level approach to the meningitis pathogen *Neisseria meningitidis* and the human and bovine TB pathogens, *Mycobacterium tuberculosis* and *M. bovis* constructed and utilised genome-scale metabolic models of both pathogens to reveal how they interact with the host nutrient environment and innate and adaptive immune responses **(Beste, McFadden, Stewart, Salguero-Bodes**). This resulted in grants from the BBSRC (£1.2m), EPSRC (£0.65m) EraSysBio+/BBSRC (£1.2m) and EC FP6 (£0.55m), as well as funding from the Wellcome Trust (£0.95m), MRC (£0.5m) plus industrial sponsorship from Sanofi Pasteur (£1.0m). Some of this support led to genome sequencing of ancient DNA from the leprosy bacillus published in Science **(Stewart)**. Work on the pathogenesis of *E. coli* and *Brachyspira pilosicoli* including the identification of colonisation sites and development of a poultry *E. coli* vaccine was achieved in collaboration with AHVLA **(La Ragione).** Animal models have also been developed to study virulence of agents such as *Vibrio parahaemolyticus* **(Ritchie)** and *Burkholderia pseudomallei* **(Salguero-Bodes)**. High-throughput functional genomic studies of *M. tuberculosis* revealed the complex interactions between host and pathogen that are responsible for disease (**Stewart**). Our BBSRC/DEFRA funded (£0.8m) virology research has focused on unravelling how viruses interact with the host cell machinery to cause diseases such as gastroenteritis, respiratory disease, AIDS or cancer in animals and man. Our work has elucidated the role of HIV RNA in modulating the activity of viral Gag protein, the identification of novel IRES elements within the genome of the oncolytic virus Seneca Valley Virus and Avian Encephalomyelitis Virus, and the role of the cellular protein FBP1 during Enterovirus 71 infection (**Locker, Roberts**). We have also identified the novel mechanism of translation initiation of calicivirus RNAs and the role of the viral protein VPg in this process **(Roberts)**. Further understanding of intracellular virus-host interactions has been made through the study of the oncogenic Kaposi's sarcoma-associated herpes virus that in turn has enhanced molecular knowledge of normal cellular processes, including innate and adaptive immune regulation (**Blackbourn**). Discovery of immune modulators in poxvirus has allowed elucidation of their structure, their mechanisms of action and their contribution to virulence in animal models **(Maluquer de Motes)**. Collaboration with the Pirbright Institute has elucidated the host-vector-virus interaction for the bluetongue virus and demonstrated the importance of vector insect saliva on transmission and infectivity **(Darpel)**. A new model for herpes simplex virus morphogenesis has been developed by combining detailed ultrastructural analyses with human RabGTPase screening; a model that could have implications across the herpesvirus family and beyond (**Elliott, G**). Applied mathematical and immunological tools have been used to investigate how cytomegalovirus and HIV interact with the host immune response and novel nano-diagnostics for HIV have also been developed **(Emery)**. Translational vaccine research (EC FP7, Gates Grand Challenge) identified toxicity of enterotoxoid mucosal vaccine adjuvants, not predicted in extensively published animal models, and provided a basis for the €30m Innovative Medicines

Initiative BIOVACSAFE award to identify human biomarkers of vaccine immunosafety **(Lewis)**.

Nursing & Healthcare group.

The group undertakes research to improve nursing and healthcare practice, as well as informing healthcare theory and policy. Much of the translational work integrates with our biomedical research, particularly in oncology, diabetes and cardiovascular diseases. An innovative e-health system has been developed and evaluated to support people with cancer and long-term conditions spanning several patient populations, including Europe and Australia **(Maguire)**. Support needs for men with prostate cancer have been identified with the first European study to link how packages of care impact on the long-term health needs of men, leading to the development and evaluation of interventions to improve survivorship care **(Faithfull)**. The UK Stroke Survivor Needs survey **(Redfern)** was the first national study to quantify the extent of unmet needs of longer-term stroke survivors and our research has also re-shaped national and international guidelines for emergency care of heart attack and stroke **(Quinn).** Studies of the use of hormonal contraception by women with diabetes highlighted that, although safe for most women, it is often not prescribed for this group for whom reliable contraception is essential **(Shawe).** Our work was also used as key evidence in the House of Commons Health Committee on patient safety **(Magnusson)** and our studies assessing the clinical value of some advanced surgical techniques has demonstrated adverse effects on patient experiences of treatment **(Ballard)**.

Nutrition, Metabolism & Diabetes group.

The aim of this research group is to understand the metabolic and molecular origins of nutrition-related disease, and to identify the optimal nutritional requirements for human health throughout the lifecycle. We have identified population-level nutrigenetic differences that have shown the impact of age on micronutrient status and disease **(Ahmadi)** as well as nutrigenomic studies showing nutritional modulation of DNA damage and repair in response to vitamin D and selenium depletion and loading **(Elliott, R)**. BBSRC-funded (£0.7m) research has provided insight into understanding how dietary fatty acids and sugars influence cardio-metabolic risk, and studies on dietary cholesterol have prompted the revision of national guidelines to lift restrictions on the intake of cholesterol-rich foods **(Griffin)**. BBSRC and charity funding (£0.8m) has also enabled a breakthrough in systems modelling of the liver's dynamic response to dietary perturbations **(Moore)** and provided novel insights into how diet influences both liver health and the molecular pathogenesis of non-alcoholic fatty liver disease **(Moore, Hart)**. In studies supported by EFSD, Novo Nordisk and Diabetes UK, the kinetic modelling of whole body lipid and glucose metabolism in obesity, metabolic syndrome and diabetes has provided key insights into the pathophysiology of these conditions **(Umpleby, Fielding).** We have also shown successful reversal of metabolic syndrome by PPARdelta agonists without increasing oxidative stress **(Fielding)**. New appointees in exercise and sports physiology have shown blood flow restriction as an exercise modality for enhancing vascular function and human performance **(Hunt)**, and low to moderate intensity exercise as a means of improving glycaemic control and metabolic capacity in type-2 diabetes **(Manders)**. Research supported by the Wellcome Trust (£0.2m) on the effects of selenium on human health has defined the impact of this mineral on pregnancy outcomes, thyroid function, and diabetes **(Rayman)**. Work supported by BBSRC-DRINC (£0.8m) and FSA (£0.6m) funding has demonstrated both the relative efficacy and mechanisms of action of vitamin D2 and D3 on bone disease in Caucasian and Asian women, and also led to dietary-induced reduction of bone fractures in military personnel **(Lanham-New)**. Recent appointees in food security and nutritional epidemiology bring additional impact to our nutritional research with the discovery of antimicrobial efficacy of essential oils in the fight against food-borne pathogens and spoilage bacteria **(Gutierrez**) and cohort profiling of the two largest national databases of dietary intake (NDNS), and health and age-related disease (NSHD) **(Lennox)**.

Sleep, Chronobiology & Addiction group.

The activity of this group includes basic, clinical and translational research relevant to the negative health outcomes associated with insufficient and mistimed sleep that are highly prevalent in our society. These research efforts are made possible, in part, by our world-class clinical research facilities. Significant achievements, supported by grants from US-AFOSR (£1.3m) and BBSRC

(£1.1m), during the REF period include the demonstration that insufficient sleep leads to considerable changes in expression levels and circadian organisation of the human transcriptome **(Archer, Dijk, Smith**). Additional work has examined the cognitive decline associated with sleep loss (**Archer, von Schantz**) as well as fMRI assessed neural responses associated with genetically determined individual differences in the response to sleep loss and circadian misalignment **(Archer, Dijk)**. This work on the genetic basis of individual differences in the response to sleep loss has now been extended to gene knockout animal models **(Van der Veen)**. Research funded by the BBSRC (£1.2m) has focused on the impact of food timing on human circadian rhythmicity **(Johnston, Skene, Archer**). In the area of addiction, during the assessment period we were the co-ordinating partner in a £7m EC FP6-funded project on the assessment of the genomic basis of addiction; this work has led to key insights into the neurobiology of addiction and identified novel targets with potential for treating relapse to drugs of abuse **(Bailey, Kitchen)**. Building on our longstanding world leading research on the effects of light on human circadian physiology (EC FP6 and Marie Curie, £1.3m) and supported by the lighting industry (NDA £1.9m), we established age-related changes in the responsiveness to monochromatic light (**Skene**) and have been funded by the BBSRC (£0.7m) to examine the effects of sleep and circadian rhythmicity on the human metabolome **(Skene)**. Novel pharmacological sleep and vigilance treatment approaches such as orexin antagonism (**Winsky-Sommerer, Dijk**) and H3 inverse agonists **(Dijk)** have been tested in clinical trials sponsored by the pharmaceutical industry and we were awarded a Lilly-Innovative Fellowship award **(Dijk, Winsky-Sommerer)** to study sleep in models of depression**,** a Lilly-BBSRC CASE studentship **(Vyazovskiy**) as well as a contract from Lundbeck to study effects of anti-psychotics on sleep and circadian rhythms. We have also established that in humans and animals sleep is not always a whole brain phenomenon, it can be local, and that the wake-sleep cycle is associated with a cycle of synaptic potentiation and depression, providing major new insights into the primordial function of sleep (**Vyazovskiy).**

Research management and promotion of research

Academic line management is formally operated through the three financially independent discipline-oriented Schools of Biosciences & Medicine, Health & Social Care and the newly established School of Veterinary Medicine. The Faculty Executive Board, comprising the Dean, Associate Deans for research and for teaching, plus the Heads of Schools have overall responsibility for strategic planning and development of research, including new appointments. The Schools are led by professorial staff, and input to line management and career development of research active academics is provided by research group leaders who also sit on the Faculty Research Committee. The Associate Dean for research leads the overall research strategy of the Faculty and all research activities are the responsibility of the Faculty Research Committee, chaired by the Associate Dean. PGR training is led and monitored by the Director of our Graduate School who is also a member of the Faculty Research Committee. The Faculty Research Committee advises the Faculty Executive Board on staffing, space, equipment, PGR training, research collaborations and forward planning. A core technology Director leads strategic development of these platforms including renewal and replacement, providing sustainable core technologies for our biomedical research. Throughout the assessment period the activities and success of the research groups has been monitored and evolution of our research structures and management has been initiated in a “bottom up” manner, through research group meetings, academic staff meetings and an annual Faculty research awayday. At a central level our Research and Enterprise Support unit provides support for grant bidding and grant management and we have an open access publication facility (Surrey Research Insight) for research dissemination.

c. People, including:
i. Staffing strategy and staff development

During the assessment period there has been a c.40% turnover of academic staff, due to strategic restructuring, retirements and an initiative to expand academic staff numbers. We have hired over 40 new academic staff in the REF period and our submission includes 14.5FTE ECRs (22%) and 25.4FTE Professors (39%). The Dean or Associate Dean for research has chaired all appointment boards. A strategy of only appointing where candidates are considered higher than a challenging

quality research threshold has ensured that the overall standard of our research continues on an upward trajectory. Further, our appointment strategy has been to grow critical mass in those areas where we have the very highest quality research, and to appoint academic staff with complementary expertise to our existing strengths. Recommendations for internal promotion are made by Heads of Schools with input from research group leaders with respect to research performance. Candidates for promotion are considered by the Faculty Executive Board, and include an assessment of research metrics performance at all promotion levels. A Dean from another Faculty is present at each promotions meeting to ensure consistency across the University. Recommendations for promotion made by the Faculty Executive Board are taken forward for approval by a University promotions committee, which includes national and international assessment at Reader level and above. During the REF period we have promoted 12 academic staff included in this submission at all levels (*Lecturer to Senior Lecturer/Reader:* Johnston, Winsky-Sommerer. *Senior Lecturer to Reader:* Archer, Plant, von Schantz. *Senior Lecturer/Reader to Professor:* Griffin, Kierzek, La Ragione, Lanham-New, Li, Roberts, Stewart). Included in these promotions has been the rapid development of outstanding researchers including promotions from Lecturer through to Professor within the REF period (Kierzek), Senior Lecturer to Professor (La Ragione) and promotion to Senior Lecturer during probation (Winsky-Sommerer), indicative of our commitment to reward excellence in research. In addition, five of our outstanding research fellows have been promoted to academic posts during the REF period (Beste, Coley, Fielding, Laing, Rocco) as part of our commitment to continue developing our own high quality researchers.

The University's Staff Development department enables staff to develop throughout their careers and organises induction events and a comprehensive staff development programme, as well as playing a key role in developing the appraisal system. The aim is to enable staff to develop their effectiveness, increase job satisfaction and achieve their potential. Management and leadership training is also provided, in part internally, but also by use of external leadership programmes (e.g. Leadership Foundation for Higher Education) to ensure the highest standards of top management.

Research staff career development and support

The DVC (Research and Innovation) leads the strategy for researcher development across the University. Oversight and governance rests with the University Research and Enterprise Committee chaired by the DVC. To implement the Concordat to Support the Career Development of Researchers, in 2011, the University undertook an institution-wide gap analysis and established our Researcher Development Programme. In addition to its services for PGR training (see section c), it offers workshops for ECRs as well as experienced researchers, covering topics including research project management, publication, funding and impact. It is delivered by a central specialist team (5 FTEs), with input from the careers service, Research and Enterprise Support, languages and our higher education department. The scope and reach of the programme expanded substantially during the REF period with a doubling of workshops (now *c*. 200) running annually. The programme for staff in postdoctoral posts is based on a mapping of needs and the resulting action plans provide enhanced personal career service, grant writing mentoring, interdisciplinary mobility (supported by the EPSRC MILES programme), and industry exchanges for postdoctoral staff.

Support of equality and diversity

The Staff Development department, guided by the University's Equality and Diversity Committee which is chaired by a lay member of Council, provides Equality and Diversity training to all levels of staff, and there is a University-wide flexible working policy for all staff. The University is committed to meeting its legislative responsibilities under the requirement of the Equality Act 2010 and was awarded an Athena SWAN Bronze University Award in 2013. In 2012 Surrey was awarded an HR Excellence in Research award; this concordat encourages the recruitment and retention of researchers from the widest pool of talent, including those from diverse backgrounds.

ii. Research Students

Associated with the establishment of a new Faculty structure at the University in August 2007, was the development of our Graduate School. The FHMS Graduate School was the first to be established at the University of Surrey in 2008. A director appointed by the Dean and overseen by the Associate Dean for research leads the Graduate School. The Graduate School improves the operational and organisational aspects of postgraduate study, merging best practice across the Faculty, and provides a vehicle for cohesive generic training in the Faculty, ensuring effectiveness across all Schools. In addition, it acts as a home and gives identity to postgraduate students within a large Faculty structure. This permits greater networking among peers across disciplines, which increases engagement and improves the student experience. The Graduate School also increases external visibility and this has led to increased overseas applications for PGR training in the REF period. An annual Festival of Research is held in July to celebrate the research success of all staff (academic, postdoctoral, postgraduate). With oral and poster presentations, as well as keynote speakers, this is a forum for increasing the quality of graduate research, and for increasing communication and collaboration. The Festival includes a junior prize symposium where selected PGR students give oral communications on their research as well as poster prizes.

Central oversight of PGR provision rests with the Research Degrees Committee, chaired by the DVC (Research & Innovation), which reports to the University Senate. The content of the researcher development programme fully accords with the Vitae researcher development framework that incorporates precepts of the concordat to support the career development of researchers. The PGR journey progresses from induction courses, through a 12 monthly confirmation process plus support during their final year for thesis writing and viva preparation. PGRs from all Faculties organise and present at an annual University-funded PGR conference, which provides interdisciplinary enrichment for our students. The integration of postdoctoral and PGR training is a key benefit to both groups of staff. Our final PGR 3-day intensive workshop on "Success beyond Surrey" brings together academics, industry and entrepreneurs and is part of our commitment to postgraduate development.

During the REF period our full-time and part-time PGR population has grown substantially (annual intakes of 13, 27, 39, 47, 39, 42 from 07/08 to 12/13). This reflects not only the success of the Graduate School in recruiting new students, but also new MD programmes, and successes in doctoral training awards and partnerships funded by the BBSRC (Food Security DTP, 2011-2017 in collaboration with Reading, Southampton, Lancaster and Rothamsted). We have also continued to have success in attracting support for industrially sponsored studentships (fully-funded and CASE) that total nearly £2m during the REF period.

d. Income, infrastructure and facilities

During the REF period we have maintained our excellent research income against a backdrop of financial stringency in the sector. We have had notable success with both the BBSRC and the EC/EU since 2008 (>£8m each) and built substantial new partnerships in both the UK and worldwide. Backed by a strategic alliance with the University of Reading we have funded joint research projects that have been the foundation for one of the first 14 BBSRC doctoral training partnerships awarded across the UK in 2012.

At the heart of our research success has been development and support of core facilities, which provide technological infrastructure platforms for our research activity. These include our Surrey Clinical Research Centre, which is MHRA accredited for Phase 1 trials. Our clinical facilities are staffed by over 40FTEs and have a typical annual income over £3m. The unit is functional as a GMO facility and support trials for viral therapy. Our other core facilities include a state of the art animal unit, a bioinformatics centre and dedicated omic technologies. Each core facility area is run by a senior member of technical staff and overseen by an academic lead. To ensure sustainability and development of our core technologies we made a Professorial-level director appointment during the REF period. The director is responsible for leading the strategic development of cost effective and state-of-the-art technologies that are key to our research activity. The core

technology Director directly feeds into the Faculty planning process, to ensure the advancement and sustainability of our key biomedical platforms.

In the REF period we have provided substantial additional funding to our core facilities on top of the £26.5m invested in the previous RAE period. A further £2.1m has been spent on infrastructure projects benefiting research, including £1.4m on upgrading our clinical research facilities, £0.5m on the creation of a Veterinary Pathology facility and £0.4m to provide a second Category III facility with animal containment capability. £3.7m has been spent on new and 'add-ons' for research equipment and instruments since 2008, and £0.8m has been committed for extending our animal facility for the biomedical sciences. Finally, the University has committed £45m to the building of a new School of Veterinary Medicine, which included £5m seed funding support from HEFCE. In addition to a state of the art clinical skills facility in the new School costing over £5m, an additional £5m has been earmarked for research equipment.

All of our PGR students are supported with new desktop computers, dedicated study space, and funding to attend and present at conferences. In assessing PGR projects at the outset, the Director of Graduate studies ensures sufficient bench fees and consumable expenses are in place to enable the highest standards of experimental work. To facilitate central training of researchers a £13.2m library extension was opened in 2011 as part of our commitment to providing the highest standard of research environment for both our PGR and postdoctoral staff. An entire floor of our library is now dedicated for the Research Development Programme, with a training room, an IT lab and an informal study space, the "Researcher Zone", reserved for PGRs and PDRAs.

During the REF period the University has devoted considerable resource to fostering international partnerships, under the direction of a PVC (International) and with the support of an Associate Dean (International) in each Faculty. A keystone in this has been the creation of the University Global Partnership Network (UGPN) established in 2011 involving formal strategic research alliances between Surrey, North Carolina State University and the University of Sao Paulo. International collaborations within and outside of this network are actively fostered and supported. An annual UGPN joint research fund of £120k pump primes bilateral and trilateral projects and collaborations are also supported by additional funds held by our International Relations Office and by the Faculty (£170k p.a.). Increased leverage is obtained by sponsorship and matching funding from external organisations including sponsorship from the Santander Universities network (£150k) to foster research collaborations with a number of global universities. Collaborations with the University of Sao Paulo are supported through a collaborative agreement with FAPESP, the Research Council of Sao Paulo, who match the funds provided by the University. As strategic partners of the University of Sao Paulo, Surrey academics are eligible for fully-funded visiting professorships. The University is also actively supporting academic collaborations through PhD supervision by successful participation in the Brazilian Science without Borders programme. Externally funded joint research projects are now growing with Sao Paulo and include shared studentship training that will lead to dual degree awards.

e. Collaboration or contribution to the discipline or research base

Many staff have received major recognition for their contributions to biomedical and health research disciplines and have carried out significant scholarly work for learned societies, conferences and government panels. Collaborations with industry, NHS and government partners and global collaboration have grown substantially. Details for the REF period are listed below:

National or International Committee membership

National Cancer Research Network Brain Tumour Novel Agents Subgroup **(Ajaz).** Research Network Committee, European Sleep Research Society; Committee on Trainee Research Awards, Society for Research on Biological Rhythms **(Archer).** NIHR South East Coast Regional Funding Committee; BSGE Endometriosis Centres Development Committee; British Society for Gynaecological Endoscopy, Clinical Excellence Awards Scheme. **(Ballard).** Deutsche Forschungsgemeinschaft, Review Panel for Clusters of Excellence **(Emery).** Grant committee,

Age UK; MoD, Research Ethics Committee **(Fry).** French National Scientific Evaluation Organization (AERES) **(Gerber).** BBSRC Committee A **(Johnston).** BBSRC Tools and Resources Development Fund Panel; BBSRC Bioinformatics and Biological Resources Fund Panel; BBSRC Industrial Biotechnology Strategy Panel **(Kierzek).** NC3Rs Grant Assessment Panel **(Kitchen).** DEFRA Avian Expert Group Committee and Poultry Diseases Group; Infectious Diseases Research Network Steering Committee; Specialist Advisory Committee for Veterinary Pathology, Royal College of Pathologists **(La Ragione).** Public Health England Scientific Advisory Committee on Nutrition; TSB/BBSRC Grant Committee **(Lanham-New).** International Life Sciences Institute Expert Groups; British Nutrition Foundation Task Force on Developmental Programming and Diet; Project Board, National Diet and Nutrition Survey; Project Board, Diet and Nutrition Survey of Infants and Young Children **(Lennox).** HSE, Scientific Advisory Committee on Genetic Modification; WHO Steering Committee on New Vaccine Delivery Systems; Human Vaccines Committee, International Association for Biological Standardisation, NIHR South East Coast Regional Funding Committee **(Lewis).** BBSRC Committee B; NIH/NIAID Special Emphasis Panel; Meningitis UK's Scientific and Medical Advisory Panel **(McFadden).** Chairman, Working Party on Gene Nomenclature, International Society of Thrombosis & Haemostasis; Coagulation Factor Databases Working Group, European Association for Haemophilia and Allied Disorders **(McVey).** DoH Expert Advisory Group for Clinical Guidelines for Non-alcoholic Fatty Liver Disease. **(Moore).** National Cancer Research Network Clinical Studies Group **(Pandha).** Committee for Toxicity on Chemicals in Food, Consumer Products and the Environment; Commission on Human Medicines Pharmacovigilance Expert Advisory Group; NC3Rs Grant Assessment Panel **(Plant).** DoH Emergency Cardiac Board; Myocardial Ischaemia National Audit Project steering group; Clinical Lead, NHS Evidence, NICE; Board Member, NIHR CLRN, Surrey and Sussex **(Quinn).** Working Group for the Innovation R&D Metrology Programme of the National Measurement Office **(Rayman).** DEFRA Pig Expert Group Committee **(Salguero-Bodes).** Advisory Group for Commissioning of Contraception & Abortion Services **(Shawe).** WHO Working Group on the Pathogenesis of Buruli Ulcer **(Simmonds).** Coordinator, Research Networking Committee, European Sleep Research Society; International Committee on Illumination; National Sleep Foundation Expert Panel **(Skene).** Expert Advisor: Health Innovation Challenge Fund **(Smith).** Scientific Advisory Board, FP7 TB-VIR Programme on Tuberculosis, **(Stewart).** Danish Medical Research Council Grant Committee **(Umpleby).**

Membership of executive/management committees of professional bodies *Most staff in the submission have been members of scientific and programme organising committees for national and international conferences. Listed below are key management and executive roles:*

South of England Cancer Drugs Fund Specialist Opinion Panel; West London Cancer Network CNS and Brain Tumour Working Group **(Ajaz).** Chair (2012-14), Scientific Committee, European Sleep Research Society; Royal Society Grant Scheme Panel **(Archer).** General Secretary, Council of the Society for General Microbiology; Council Member, Federation of Experimental Microbiological Societies **(Blackbourn).** Vice-President, World Sleep Federation **(Dijk).** President, European Oncology Nursing Society **(Faithfull).** Treasurer, European Lipoprotein Club **(Fielding).** Chair, Scientific Development Committee, International Consultation on Incontinence **(Fry).** Board of Councillors of the International Fibrinogen Research Society **(Green).** Nutrition Society Theme Leader **(Griffin).** Council Member, Nutrition Society **(Hart).** Meetings Secretary, British Society for Neuroendocrinology **(Johnston).** Chair, UK Committee of Heads of Pharmacology & Therapeutics; Council Member, British Pharmacological Society; President, European Opioid Conference; Executive Committee, International Narcotics Research Conference **(Kitchen).** President, Med-Vet-Net Association **(La Ragione).** Scientific Committee, British Nutrition Foundation and National Osteoporosis Society **(Lanham-New).** Scientific Committee, British Nutrition Foundation **(Lennox).** Association of Cancer Physicians **(Pandha).** MHRA Nicotine Containing Products Working Group **(Plant).** Board Member, European Society of Cardiology, Acute Cardiovascular Care Association; ESC Council on Nursing and Allied Professions Advisory Board **(Quinn).** Trustee, Daphne Jackson Trust **(Rayman).** Society for General Microbiology Virus Committee **(Roberts).** Royal College of Obstetricians and Gynaecologists, Sexual & Reproductive Health Clinical Studies Group **(Shawe).** Vice-President, European Biological Rhythms Society; Vice-President, European Sleep Research Society; Chair,

Gordon Research Conference on Pineal Cell Biology **(Skene).** Scientific Advisory Board, International Society of Biology of Actinomycetes; Scientific Advisory Board, Korean Society for Microbiology & Biotechnology **(Smith).** Chair, (2010-12) Scientific Committee, European Sleep Research Society **(von Schantz).** Coordinator: ESRS forum for Women in Sleep Research **(Winsky-Sommerer).**

International & National awards or prizes *During the REF period senior staff have been elected Fellows of learned societies and staff have won prizes for their scientific achievement:*

Fellow of the Royal College of Pathologists **(La Ragione**, **McVey, Salguero-Bodes).** Fellow of the Society of Biology **(Blackbourn, Dijk, Emery, Kitchen, La Ragione, Lanham-New, McFadden).** Royal Society Wolfson Research Merit Award **(Dijk, Skene).** Aptuit Prize, British Pharmacology Society, 2010 **(Bailey).** Young Investigator Award, European Society of Cardiology **(Camelliti).** Fellow, European Academy of Cancer Sciences **(Faithfull).** The Nutrition Society Cuthbertson Medal, 2010 **(Fielding).** Fellow of the Royal College of Surgeons, Edinburgh **(Fry).** DEFRA Science Award 2009 **(La Ragione).** Fellow, Chinese Life Sciences Society **(Li).** Fellow of the American College of Cardiology **(Mahmoudi).** American Society for Pharmacology and Experimental Therapeutics, Drug Metabolism Award **(Plant).** Fellow of the American Heart Association **(Quinn).** Diplomate, European College of Porcine Health Management **(Salguero-Bodes).** Young Investigator Award, Sleep Research Society, 2008 **(Vyazovskiy).** Award for Outstanding Basic Sleep Research 2009: Swiss Society of Sleep Research **(Winsky-Sommerer).**

Journal editorships *Many staff in the submission have acted in an editorial capacity for journals (including Chief, Deputy and Associate Editors) and a selection is listed below:*

British Journal of Pharmacology **(Bailey).** Journal of General Virology **(Blackbourn).** British Journal of Cancer **(Coley).** Journal of Sleep Research; Sleep **(Dijk).** Journal of General Virology **(Elliott, G).** Nutrition Research Reviews **(Elliott, R).** American Journal of Transplantation; Reviews in Medical Virology **(Emery).** British Journal of Nutrition **(Fielding).** Surgery; Neurourology and Urodynamics **(Fry).** PLoS ONE; PLoS Biology **(Gerber).** British Journal of Nutrition; Atherosclerosis **(Griffin).** Journal of Human Nutrition and Dietetics **(Hart).** Journal of Neuroendocrinology **(Johnston).** Journal of Medical Microbiology; Journal of Veterinary Microbiology **(La Ragione).** Osteoporosis International **(Lanham-New).** European Journal of Clinical Nutrition **(Lennox)**. Human Mutation; Thrombosis and Haemostasis; Journal of Thrombosis and Haemostasis; **(McVey).** BMC Cancer **(Morgan).** Xenobiotica **(Plant).** European Heart Journal: Acute Cardiovascular Care **(Quinn).** Journal of Family Planning and Reproductive Health Care **(Shawe).** Chronobiology International; Journal of Sleep Research; **(Skene).** Microbiology **(Stewart).** Growth Hormone and IGF Research **(Umpleby).**

Keynote and Plenary lectures
Most staff have presented invited symposium talks at international conferences during the REF period, and many have chaired and led sessions at prestigious meetings, including Gordon conferences and Keystone symposia**.** Keynote talks have been given at the world's largest society meetings including the Associated Professional Sleep Societies, American Society for Microbiology, American Heart Association and the World Congress on Gerontology and Geriatrics.

Key academic collaboration *The excellence of our research has been recognised globally. During the REF period more than two thirds of staff have collaborated and published with 44 of the worldwide top 100 Universities (THE 2013 World rankings) as detailed below:*

Harvard University **(Agouni, Ahmadi, Dijk, Emery, Jimenez, McVey, Rayman, Ritchie, Simmonds, Skene).** University of Oxford **(Camelliti, Emery, Fielding, Green, McFadden, Quinn, Rayman, Redfern).** Stanford University **(Gerber).** Massachusetts Institute of Technology **(Jimenez, Miera).** University of Cambridge **(Blackbourn, Elliott G, Gerber, Lennox, Mahmoudi, Maluquer de Motes, Quinn, Roberts, Salguero-Bodes, Umpleby).** UC Berkeley **(McFadden).** Imperial College **(Coley, Fry, La Ragione, Lanham-New, Lewis, McVey, Roberts, Simmonds, Stewart, Umpleby).** UCLA **(Camelliti, Gutierrez, Morgan, Pandha).** ETH Zurich – Swiss

Federal Institute of Technology (**Gerber, Rayman).** Johns Hopkins University **(Rayman).** University of Pennsylvania **(Agouni).** University of Toronto **(Agouni).** University College, London **(Camelliti, Elliott G, Emery, Fry, Lanham-New, McVey, Quinn, Shawe).** University of Washington **(Camelliti, Emery, McVey).** University of British Columbia **(Manders).** UC Santa Barbara **(Jimenez).** Karolinska Institute **(Ahmadi Emery, Fry, Green).** Ecole Polytechnique Federale de Lausanne **(Stewart, Winsky-Sommerer).** Kings College, London **(Fry, Maguire, McVey, Moore, Redfern Umpleby).** University of Edinburgh **(Johnston, La Ragione).** Washington University in St Louis **(Camelliti).** Seoul National University **(Smith).** University of North Carolina at Chapel Hill **(Blackbourn).** Boston University **(Winsky-Sommerer).** Ludwig-Maximilian University, Munich **(Gerber, Skene).** Korea Advanced Institute of Science and Technology **(Smith, Laing, Locker).** University of Manchester **(Aukim-Hastie, Lanham-New, Plant, Smith).** University of Leuven **(Manders, McVey).** Purdue University **(Kierzek).** University of Leiden **(Laing, Simmonds, Smith).** University of Sydney **(Dijk, Redfern).** Erasmus University, Rotterdam **(Ahmadi, Shawe, Skene).** University of Basel **(Archer, Dijk, Gerber).** Utrecht University **(Gómez Álvarez).** University of Pittsburgh **(Fry).** University of Bristol **(Lennox).** Tufts University **(Ahmadi).** University of Amsterdam **(Manders).** Ghent University **(Gómez Álvarez, Salguero-Bodes, Shawe).** University of Notre Dame **(Van der Veen).** UC Irvine **(Pandha, Salguero-Bodes).** University of Colorado, Boulder **(Camelliti).** University of Groningen **(Van der Veen, Smith).** University of Helsinki **(Pandha).**

Collaboration or integration with external bodies *Collaborative research also emanates from key interactions with industry, the NHS and government institutions listed below:*

Industry. ACE BioSciences **(Lewis).** ANGLE plc. **(Aukim-Hastie, Pandha).** ArcelorMittal **(Skene).** Astra Zeneca **(Green, Quinn).** Bayer Pharmaceuticals **(Coley).** Boehringer Ingelheim **(Quinn).** Boston Scientific **(Fry).** Campden BRI **(Hart, Lanham-New).** Chembio Diagnostics **(Chambers).** British Dairy Council **(Griffin).** Covance **(Dijk).** Danone **(Lanham-New).** Eli Lilly **(Dijk, Fry, Winsky-Sommerer).** ElectroSpinning **(Coley).** Ferring Pharmaceuticals **(Dijk).** Genelux GmBH **(Ajaz).** GSK **(Camelliti, Dijk, Lewis, Pandha).** GNOSYS **(La Ragione).** Immunocore **(Pandha).** iQur **(Pandha).** Lundbeck **(Dijk, Lewis, Winsky-Sommerer).** Merck **(La Ragione).** Nestle Research Centre **(Ahmadi, Elliott).** Novartis **(La Ragione, Lewis, Morgan).** Novo Nordisk **(Umpleby).** Oncolytics **(Pandha).** Ono-Pharmaceuticals **(Dijk).** Pevion Biotech **(Lewis).** Pfizer **(Fry).** Phillips **(Dijk, Maguire, Skene).** Probiotics International **(La Ragione).** Roche **(Ajaz, Emery, Morgan).** Sanofi **(Emery, Lewis, McFadden, Pandha, Umpleby).** Staten Serum Institute **(Lewis).** Symbio **(Laing).** Takeda **(Fry).** Uniliver **(Moore).** Vertex Pharmaceuticals **(Coley).** Viralytics **(Pandha).** Virttu Biologics **(Ajaz).** Wassen international **(Lanham-New).** Zoetis Animal Health **(La Ragione).**

Health Care Partners. Ashford & St Peter's NHS Trust **(Ballard).** Experimental Cancer Medicine Centres network **(Ajaz).** Epsom & St. Helier NHS Trust **(Lewis).** Frimley Park Hospital NHS Trust **(Shawe).** Kings College Hospital **(Ajaz, Hart, Moore).** Papworth Hospital **(Mahmoudi).** Queen Alexandra Hospital, Portsmouth **(Aukim-Hastie).** Royal Brompton & Harefield NHS Trust **(Camelliti).** Royal Marsden Hospital & Institute of Cancer Research **(Ajaz).** Royal National Throat, Nose and Ear Hospital **(Ahmadi).** Royal Surrey County Hospital **(Coley, Green, Umpleby).** St Thomas' Hospital **(Ahmadi).** Surrey & Borders Partnership NHS Trust **(Bailey).** UCL partners **(Emery).** University Hospital Leuven **(Laing).** University Hospital Southampton NHS Trust **(Mahmoudi).** Washington Hospital Centre DC **(Mahmoudi).**

Government and allied organisations. AHVLA **(Chambers, La Ragione, Laing, Salguero-Bodes).** Centre for Environment, Fisheries & Aquaculture Science **(Ritchie).** Food & Agriculture Organization of the UN **(Salguero-Bodes).** Food & Environment Research Agency **(Chambers).** Health Protection Agency **(La Ragione, Lewis).** MoD **(Lanham-New).** Moredum Research Institute **(Gutierrez).** NatCen Social Research **(Lennox).** National Centre for Infectious Diseases Models & Innovative Therapies, France **(Lewis)** NIH **(Roberts).** Pirbright Institute **(La Ragione, Laing, Roberts).** Veterinary Medicines Directorate **(La Ragione).** Veterinary Research Laboratories, Ireland **(Gutierrez).**