

Institution: Kingston University
Unit of Assessment: 3 – Allied Health Professions, Dentistry, Nursing and Pharmacy
1. Unit context and structure, research and impact strategy

1.1 Unit Context and Structure

Kingston University's (KU's) UoA3 research encompasses fundamental biomedical science, biology of health and disease, sport and nutrition, drug delivery, diagnostics and pharmaceuticals, through to the implementation/evaluation of novel health, social care and patient care delivery. Our research is conducted within two Centres:

- 1) The Interdisciplinary Hub for the Study of Health and Age-Related Conditions (IhSHA; 61 staff, 60 FTE)**, based in the Faculty of Science, Engineering and Computing (SEC). IhSHA addresses fundamental and applied biomedical and technological questions towards the maintenance of health, disease processes and diagnosis, and therapeutic interventions. The Centre benefits from wide-ranging external collaborations and its close proximity to internationally recognized organisations such as GlaxoSmithKline (GSK) and Laboratory of the Government Chemist (LGC) Ltd.
- 2) The Centre for Applied Health and Social Care Research (CAHSCR; 31 staff, 25.7 FTE)**, based in the Faculty of Health, Social Care and Education (HSCE), a joint venture between Kingston University and St George's, University of London (SGUL). CAHSCR addresses questions generated by the practice of nursing, midwifery, paramedic and rehabilitation, on health promotion, treatment and care for patients with long-term conditions (including musculo-skeletal conditions, stroke, dementia and mental illness), and associated workforce development. The Centre benefits from co-location with St George's Hospital, and collaborations with a large network of health and social care providers, the South London Academic Health Science Network, and the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care (CLAHRC) - now Applied Research Collaboration (ARC) for South London.

Researchers working within the two Centres are grouped into nine non-exclusive research areas (Themes; Table 1).

Table 1. Staff research areas (Themes) with new* (post-REF2014) staff appointments and early career researchers^{ECR} (post-August 2016) indicated.

	Research Theme	Staff
IhSHA (led by Naughton)	Diabetes and Cardiovascular Pathologies (DCP)	Hill (Lead), Arrigoni, Buxton*, Mackenzie ^{ECR} , Snabaitis, Stolinski.
	Cancer Research (CR)	Modjtahedi (Lead), Ashrafi, Chioni*, Dorak*, Elbediwy ^{ECR} , Gaymes*, Khelwatty ^{ECR} , Seddon.
	Infection and Immunity (I&I)	Walker and Fielder (Leads), Garrido Mesa*, Jones L, Karlyshev, Kelly, Kirk, Lawton, Snyder.
	Drug Discovery, Delivery and Patient Care (DDPC)	Alany and Kayyali (Leads), Aldabbagh (Al-Dabbagh)*, Al-Kinani*, Barker, Beadham*, Bear ^{ECR} , Buonocore ^{ECR} , Busquets*, Calabrese, Crilly*, El Nabhani (Nabhani-Gebara), Elshaer*, Khoder*, Le Gresley, Morgan A*, Perera ^{ECR} , Peron ^{ECR} , Polycarpou*, Rooney ^{ECR} , Shearman*, Thatti ^{ECR} , Vangala, Wren*.
	Sport, Exercise, Nutrition and Public Health (SENP)	Moir (Lead), Allgrove, Brouner, Morgan H, Naughton, Opara, Owusu-Sekyere ^{ECR} , Petróczi (Petroczi), Pummel, Richards* (formerly Manning), Schwikkard, Spendiff, Swann, Yarandi ^{ECR} .

CAHSCR (led by Harries)	Emergency, Cardiovascular and Critical Care (ECCC)	Quinn (Lead)*, Halter*, Kulnik*, Lear* ^{ECR} , McKeever*, Mellinghoff* ^{ECR} , Wang*.
	Inclusive Health and Wellbeing (IHW)	Coxon* & Nikolettou (Leads), Calestani*, Hallett*, McRae*.
	Implementation and Improvement (I&IMP)	Boaz & Jones F (Leads), Collins*, Drennan, Gale, Harries*, Hurley, O'Shea*, Price*, Taylor E* ^{ECR} .
	Psychological and Cognitive Conditions (PCC)	Chambers (Lead), Bacon*, Brearley, Cronin-Davis*, Giatras*, Mein, Taylor F*, Thomson, Tuffrey-Wijne.

Although the two Centres largely operate independently due to differing expertise, faculty location and research streams - with IhSHA focusing mainly on the fundamental and applied sciences and CAHSCR on implementation/evaluation research in health and social care services - we have developed a series of shared mechanisms, highlighted throughout this document, to achieve our overarching aims.

1.2 Unit Research

Our research spans a wide range of sub-topics across the biosciences, pharmacy, nutrition, sport science, health and social care, and medicine. Our strategy has been to concentrate on complex biomedical, health and wellbeing questions particularly those concerning ageing populations, long-term (chronic) conditions and public health, from the laboratory through to clinical and service level application. Our basic and applied research into health and disease has resulted in improvements to disease prevention and therapy, delivering associated impact, and we have ensured that our research reaches a wide global audience.

We have made **significant gains in research excellence over the last two decades**, improving from a 3A rating in RAE2001 (15.25 FTE), to 4/3/2/1* profiles of 5/20/40/25% in RAE2008 (28.30 FTE) and 10/64/25/0% in REF2014 (17.22 FTE). **In the current period, we have prioritised our research towards delivering on our REF2014 stated goals, while re-evaluating and modifying focus as required to align with UK and global research priorities to ensure continued sustainability.** We have developed mechanisms to enhance research income, promote interdisciplinary research, and grow research student and research-active staff numbers to achieve greater competitiveness. Our overarching approach has been to deepen existing areas of strength while embracing new opportunities, enhance research quality, and expand in terms of infrastructure and research active staff and students.

1.2.1 Significant Research Developments and Achievements since REF2014

i) New structures to enhance research

Basic and applied research, including that which is interdisciplinary in nature, has been bolstered within the Unit since REF2014. **IhSHA was formed as a Centre** (August 2013) to stimulate crosscutting research and has facilitated the development of new synergies and collaborations between academics, research fellows/assistants and between PhD and MSc by Research (MScR) students, which have been further supported by the completion of the new **~£2M Integrated Research Laboratory** (Section 3). The merger (2015) of Life Sciences with Pharmacy and Chemistry to form the **new School of Life Sciences, Pharmacy and Chemistry**, providing a unified research and educational environment, has enhanced the sharing of expertise and facilities. These structures have also enabled the strengthening of interdisciplinary research within the Unit, and with researchers from other Units (e.g. Engineering (UoA12) and Computer Science (UoA11)). Examples of our interdisciplinary work include studies by **Alany** (Wu *et al*, 2014, J. Control. Release; output 03-001-633), **Bear** (Patrick *et al*, 2020, Biomaterials; output 03-021-1851), **Busquets** (Viet Nguyen *et al*, 2016, Chem. Eng. J.; output 03-034-737), **Buxton** (Couto Alves *et*

Unit-level environment template (REF5b)

al, 2019, *Sci. Adv.*; output 03-040-753), **El Nabhani** (Fawaz *et al*, 2020, *Drug Design Develop. Therap.*; output 03-064-1399), **Fielder** (Jamroz *et al*, 2014, *J Antimicrob Chemother.*; output 03-072-848) **Kayyali** (Kayyali *et al*, 2016, *BMJ. Open*; output 03-115-942), **Naughton** (Karras *et al*, 2018, *Endocrine*; output 03-146-1098), **Polycarpou** (Ryan *et al*, 2017, *Brit. J. Pharm.*; output 03-161-462) and **Walker** (Hirst *et al*, 2020, *PLoS NTD.*; output 03-202-1333). These works illustrate interactions between physicists, biochemists, molecular biologists, sports and social scientists, microbiologists, vets, clinicians, geneticists, epidemiologists, engineers, pharmacists, chemists, environmental scientists, and computer scientists, both within KU and externally. **Within CAHSCR**, cross cutting research groups pursue interdisciplinary work in expert-led fields of research. Research groups (Themes; Table 1) have been established to enhance synergies, productivity, impact, and significance and reach of research in health and social care. Partnerships with CAHSCR are further developed through the **NIHR ~£9M Applied Research Collaboration (ARC) award (2019-2024)**; KU joins as a full partner HEI and holds Executive level, theme level and collaborator roles cross five themes: Patient and Public Involvement Research, Maternity and Perinatal Mental Health, Capacity Building, Implementation Research and Children and Young People.

ii) Growth

The strength of our Unit and facilities and the positive financial health of the University/faculties have enabled us to capitalise upon our REF2014 position. **Since 2014, the Unit has benefited from the appointment of 48 Category A staff** (Table 1) with expertise across the Themes in pharmaceuticals, genetics, disease mechanisms, basic biomedical science, and applied health research and practice. Therefore, our **REF2021 submission includes 92 (85.7 FTE) Category A academic staff** with significant responsibility for research, with 61 from IhSHA and 31 from CAHSCR. This contrasts 17.22 FTE in our REF2014 submission from the same Centres. While we have grown in terms of attracting new research active Category A staff, a number of existing staff have also been supported to enhance their research profiles and generate higher quality research outputs. Therefore, the total increase in submitted staff and outputs since REF2014, enables a fuller range of our UoA3 research to be assessed. **Since 2014, 163 research grants totalling ~£7.01M have been secured.** This translates to income of ~£5.65M and compares favourably to the ~£1.28M captured for REF2014 by this Unit. **Thus, in the current period, income is ~4.3 times that achieved in the entire REF2014 cycle. We have also more than doubled doctoral activity with 93 completions** (plus 10 by publication and 5 wholly overseas), contrasting 40 completions for REF2014.

iii) Investment

Since 2014, the **Unit has benefited from over ~£9M investment** by the University through various initiatives, many of which were competitively won. These include: i) 18 (15 fully-funded, 3 part-funded) postgraduate research studentships; ii) ten awards (first grant scheme; total £69K) to recently appointed staff to pump prime innovative research; iii) research transformation funding to support specialist research grant writing workshops, appointment of ECRs and a senior external mentor; iv) provision of Research Operations Managers and Business Development Managers (BDMs, two staff members) to interface with UoA3 research; v) funding for the Outreach Centre/'Labs in Lorries' reflecting our principles of impact and public outreach; vi) funding to build an Integrated Research Laboratory for IhSHA research; and vii) monies to support the acquisition of new equipment including facilities for imaging and cell biology research. In addition, CAHSCR, specifically, has invested in six postdoctoral researchers and eight PhD studentships and has supported National Institute of Health Research (NIHR)/Health Education England (HEE)-funded programmes designed to develop clinical academic careers, including three rounds of competitively won NIHR funding for the Masters in Clinical Research (MResClin) (2014-2018), now superseded by the Pre-Doctoral and Doctoral Clinical Academic Fellowship Programmes (PCAF/DCAF). We are one of two London institutions selected (2019/20) to host the initial rounds of the prestigious Internship and Pre-doctoral bridging Scheme programmes, designed to provide steppingstones for clinicians into research and onwards.

iv) Knowledge and impact

We continue to make a significant positive contribution to health and wellbeing, with associated benefit to the economy, through our research and impact activities. To represent the strength of our research we have selected 214 research outputs (from a total pool of over 1020 peer-reviewed papers by returned staff published in the period), together with seven impact case studies (ICS) to highlight the translation of our research into policy and practice. In total ~86% of the research publications submitted have been published in upper-quartile (Q1; Scimago tracked, 2019) journals, many of which are leading (top 5-10%) in their field (e.g. Nature Communications, Cell, Proceedings of the National Academy of Sciences, Development, The Lancet, New England Journal of Medicine, British Journal of Surgery, Journal of Clinical Endocrinology and Metabolism, Journal of Infectious Diseases, Heart, Palliative Medicine, Journal of Cell Science, American Journal of Epidemiology, EMBO Molecular Medicine, PLoS Medicine). Research by **Quinn, Hurley, Jones F** and **Drennan** has featured in four published NIHR themed research reviews (Care at the Scene - Research for ambulance services; Physiotherapy for Musculoskeletal Health and Wellbeing; Organisation and Quality of Stroke Services; Staffing in Hospital Wards). We continue to make significant advances with the generation of impactful research and have evolved a flexible strategy to support the development of emerging and new impact (see Section 1.3).

1.2.2 Examples of Research Activity since REF2014

The research areas (Themes) within the Unit are identified in Table 1. While researchers are associated with a core Theme, they often work collaboratively across two or more Themes due to cross cutting expertise. In REF2014 we highlighted the importance of focusing on our core research activities and enhancing national and international collaboration, including that with health and social care providers within the NHS and industrial partners, to bolster research capacity, excellence and funding. Here we outline a number of research relationships within the Unit to illustrate the nature and breadth of activity achieved within this REF period (values shown relate to research grant awards):

Within lhSHA

- (i) **Hill** (DCP Theme) leads on two projects that aim to develop a decellurised pancreas matrix for islet bioengineering and diabetes therapy, work that involves collaborations with stem cell and beta cell experts at the University of Nottingham and King's College London (KCL). Initially supported by the Novo Nordisk Research Foundation, the work has now received Diabetes UK Project Grant funding (£247K).
- (ii) **Snabaitis** (DCP Theme) leads a research programme with collaborators from Vanderbilt University and KCL, a link which has resulted in a British Heart Foundation (BHF) PhD studentship, and BHF Project Grant (£271K) to study the regulation of cardiac apoptosis and heart failure by type 2A protein phosphatase regulatory proteins (e.g. Eleftheriadou et al, 2017, Basic Res. Cardiol.; output 03-182-1224).
- (iii) **Naughton** (SENPH Theme) has led and built a long-term collaboration with GSK in oral health with several projects funded (£272K) in the period. This interaction has also resulted in two BBSRC-CASE awards with GSK (£240K) focusing on oral odour and biofilm generation. He also has significant research and policy activities in the area of food safety (see ICSUoA03Naughton6).
- (iv) **Petróczi** (SENPH Theme) has led a research programme linking with the World Anti-Doping Agency (WADA) which has proven highly successful (see ICSUoA03Petroczi7). The collaborative partnerships that she has nurtured have resulted in significant awards (£404K e.g. from the EU/International Olympic Committee (IOC)) to support research in anti-doping and drug-related research (e.g. Ulrich et al, 2018, Sports Med.; output 03-157-1148).
- (v) **Snyder** (I&I Theme) has established collaboration with **Alany** (DDDPC), a drug delivery expert, to work towards combating blindness in new-borns caused by gonorrhoea infection, a project supported (£91K) by the Children's Research Charity SPARKS (Churchward et al, 2020, Sci Reports; output 03-187-1250).
- (vi) **Walker** and **Lawton** (I&I Theme) collaborated with researchers across the globe to deliver the first annotated molluscan genome, that for the freshwater gastropod snail *Biomphalaria*

glabrata, the natural intermediate snail host for the human parasite *Schistosoma mansoni* which causes schistosomiasis in ~260M people worldwide (Adema et al, 2017, Nat. Comm; output 03-126-1407).

- (vii) **Modjtahedi** (CR Theme) has led research with oncologists at SGUL and Royal Surrey County Hospital, and **Khelwatty** and **Seddon** (CR) on novel biomarkers and antibody therapies for colorectal and pancreatic cancers. This work has principally been funded through the BRIGHT charity and the Ralph Bates Pancreatic Cancer Research Fund (£237K total) (e.g. Arias-Pinilla et al, 2020, Sci. Rep., output 03-140-1036; Khelwatty et al, 2019, Oncotarget, output 03-117-1878).
- (viii) Research conducted by several of our recently appointed staff members including **Chioni** (CR Theme; e.g. Coleman et al, 2014, EMBO Mol. Med.; output 03-050-776), **Elbediwy** (CR; e.g. Elbediwy et al, 2016, Development, output 03-066-804; Fletcher et al, 2015, EMBO J.; output 03-068-803), **Mackenzie** (DCP; Wiszniak et al, 2015, Proc. Natl. Acad. Sci.; output 03-131-996) into the fundamental cellular biology of disease mechanisms is continuing at KU, usually in collaboration with other IhSHA staff and sometimes prior institutions (e.g. **Chioni** with Queen Mary, University of London (QMUL); **Elbediwy** with The Francis Crick Institute). Such appointments have strengthened our expertise in mechanistic cellular biology.
- (ix) Within the DDPC Theme, **Le Gresley** has developed collaborations with researchers at GSK, LGC, and other companies, which aims to deliver improvements to the procedures, capabilities and effectiveness of these companies through knowledge exchange in developing advanced analytical techniques (£354K, including PhD studentship support) (e.g. Percival et al, 2020, Nutrients; output 03-127-1883); his expertise has enabled him to also secure funding from Innovate UK (£49K; with **Fielder**, I&I, and Clarity Biosolutions) to develop a rapid point of care screening system for *Staphylococcus aureus*.
- (x) In the area of healthcare improvement and service delivery, **Kayyali** and **El-Nabhani** (DDDPC Theme) have established a Technology Strategy Board (TSB)/Innovate UK funded partnership (£197K) with Exus Ltd and Croydon Healthcare NHS Trust to launch OPTIMAL. The project will deliver an integrated decision support tool for the NHS which will optimise patients' follow-up processes, particularly during the first month after discharge. OPTIMAL aims to reduce readmissions by 5% in the first year of installation. They have also recently been awarded a Horizon 2020 grant (£323K) entitled "A Multimodal AI-based Toolbox and an Interoperable Health Imaging Repository for the Empowerment of Imaging Analysis Relating to the Diagnosis, Prediction and Follow-up of Cancer" as part of a (€9.9M) project spanning 25 project partners.
- (xi) Furthermore, **El Nabhani** (DDDPC Theme) is an investigator on an EU FP7-funded collaborative project (WELCOME; ~£527K), which spans nine countries. The project will create a smart sensing vest which measures and monitors patient indicators and other information to benefit the integrated care and self-management of individuals suffering from chronic obstructive pulmonary disease and associated conditions including chronic heart failure, diabetes, anxiety and depression (e.g. Kayyali et al., 2016, BMJ Open; output 03-115-942).

Within CAHSCR

- (i) **Hurley** (I&IMP Theme) developed "Enabling Self-management and Coping for Arthritic Pain using Exercise (ESCAPE-pain)" to help older people with knee, hip and back pain. Overall, this programme has attracted over ~£1.4M in grant funding and ~£2.2M in other investment, is endorsed by NHS England, Public Health England, charity and professional bodies, and is currently being rolled out across the UK in 200 clinical and community venues (see ICSUoA03Hurley1).
- (ii) Research on caring for the elderly including those with dementia, and their carers, is undertaken within the I&IMP Theme. **Hurley** led research entitled "Active Care Homes – Increasing Physical Activity, Health and Wellbeing in Care Home Residents", funded by the Physiotherapy Research Foundation (£300K). **Drennan** led a ground-breaking investigation into the stigmatised issue of promoting continence and managing incontinence at home for people with dementia and their carers as part of an NIHR programme grant (£2M) (Iliffe et al., 2015, Southampton (UK), NIHR J. Lib., April; output 03-060-1841). The programme,

investigating all aspects from diagnosis to palliative care in care homes, involved national dementia charities as did the NIHR HTA-funded (£150K) realist study of the management of faecal incontinence in care homes (Goodman et al., 2017, Health Technol. Assess.; output 03-212-1860).

- (iii) **Jones F's** (I&IMP Theme) innovative model of stroke self-management has led to work on other complex conditions such as brain injury and progressive neurological conditions resulting in collaborations with Imperial, University College London (UCL), and international projects with Otago and Karolinska-Institute. Her work on patient-centred methodologies has been funded through NIHR and other awards (£487K in the period) and supports a successful spin-out social enterprise Bridges Self-Management Limited (see ICSUoA03Jones3).
- (iv) **Drennan** (I&IMP Theme) and **Halter** (ECCC) developed a research programme with NHS managers and HEE into innovation in the workforce, including NIHR-funded investigations into Physician Associates in primary care, leading to policy change (see ICSUoA03Drennan2) and, more recently, secondary care (£484K) (e.g. Drennan et al, 2015, Brit. J. Gen. Pract.; output 03-212-1860). Her other workforce research, including studies into new Advanced Clinical Practitioners roles and new approaches to retain nurses in the NHS acute hospital workforce has attracted significant funding (£448K) from HEE and other sources.
- (v) **Quinn** (ECCC Theme) has developed collaborations with NHS ambulance services, working, for example, on two major NIHR HTA-funded trials in out-of-hospital cardiac arrest (PARAMEDIC, PARAMEDIC-2) with Warwick Clinical Trials Unit. He leads a BHF-funded study (~£107K) with **Halter** (ECCC) exploring the use and impact of the prehospital electrocardiogram in heart attack patients (PHECG2), with three UK ambulance services. He is a member of the National Ambulance Research Strategy Group.
- (vi) **Boaz** (I&IMP Theme) has made significant contributions to applying social science in healthcare policy and research and became a Fellow of the Academy of Social Sciences in 2017; she has research collaborations across the UK and internationally, exploring how to engage stakeholders in healthcare research including in end-of-life care and tobacco control programmes (e.g. Boaz et al., 2016, J. Health Serv. Res. Pol.; output 03-024-27; MRC grant "Stakeholder engagement in EQUIPT for Impact", £84K). She was awarded an ESRC/Government Office for Science Fellowship (£81K) enabling her to apply her research to stakeholder engagement across UK government.
- (vii) **Chambers** (PCC Theme), working with NHS England, mental health trusts and national/international organisations led the development and implementation of the Therapeutic Engagement Questionnaire (TEQ; £58K Department of Health and Burdett Trust) designed to measure the importance of therapeutic engagement and its impact on mental health service user recovery (see ICSUoA03Chambers5). The TEQ tools have been translated into five languages (e.g. Chambers et al, 2019, BMC Psychiatry; output 03-048-55). **Chambers** also leads the Patient and Public Involvement Research Theme in the South London CLARHC and ARC (£157K) and was commissioned by the Health and Care Professions Council to evaluate their standards of education training in relation to newly qualified professionals' fitness to practice (£60K).
- (viii) **Tuffrey-Wijne** (PCC Theme) leads research into palliative care and people with learning disabilities in collaboration with charities and third sector organisations. Her research on death-related communication has influenced practice globally and has contributed to national policy (see ICSUoA03TuffreyWijne4). She established and leads the Taskforce on Intellectual Disability of the European Association of Palliative Care and is coordinating an international investigation of end-of-life care provision with researchers across 10 countries. She is co-investigator (£234K) on an £0.9M NIHR research project with Oxford University developing support measures to help older people with intellectual disabilities living at home with elderly carers, and their families, to plan ahead for times of transition and end-of-life.
- (ix) **Harries** (I&IMP Theme) leads research on clinical decision making. Her study of expert peer reviewers' decisions on health grant applications was one (Co-PI, ~£175K, 2019, returned under KU UoA17) of four inaugural awards from the Wellcome Trust's Research on Research Institute. She recently completed Marie Curie funded research with UCL, as

collaborator, on experts' ability to identify the end-of-life stage, including work demonstrating that the expert decision approach could improve medical students' ability to recognise when a person is dying (e.g. White et al., 2019, Palliative Med.; output 03-092-252). Her research in other areas includes referral prioritisation and studies of mobility management.

- (x) Our response to national priorities/needs is highlighted by the rapid-response research and engagement conducted by Centre staff on Covid-19. For example, **Tuffrey-Wijne** (PCC Theme) developed a guide entitled "When someone dies from coronavirus: a guide for families and carers" (now included in Government guidance) and an online resource "How do you talk about Covid-19 to people with intellectual disabilities?". **Mellinghoff** (ECCC) investigated the importance of personal protective equipment in intensive care units: "Personal protective equipment and intensive care unit healthcare worker safety in the Covid-19 era (PPE_SAFE): an international study" (Tabah et al, 2020, J Critical Care, 59, 70-75; output 03-138-1006). Other projects include those by **Nikoletou** (IHW), "The impact of Covid-19 when living with fibrotic lung conditions" and **Boaz** (I&IMP) "Adoption of innovations in the ICU in response to Covid-19".

1.2.3 Future Research Plans and Mechanisms to Achieve Goals

Over the next six years **we plan to deepen our basic and applied research within the life and health sciences**. We shall **maintain a focus on our research strengths** which encompass diagnostics, disease mechanisms and infection, drug development for disease, healthcare, nursing, paramedics and rehabilitation. However, we will also **embrace new opportunities as they emerge**. We plan to **further increase our PhD student numbers, as well as our externally funded research**, increasing funding particularly from the major charities, NIHR, and RCUK.

The mechanisms by which we aim to achieve these strategic goals are broadly founded upon our existing strategies that have proven successful in the current REF period. Where possible, appointment of replacement academic staff (Section 2) will be focused in areas of strength to build capacity. We plan to continue to provide postdoctoral funding (Section 2), allocated competitively to projects demonstrating high chance of success and potential to deliver outstanding research outputs/impact. Staff development opportunities (Section 2) will enable emerging researchers to develop into independent research leaders. Sabbatical leave funding offered usually on an annual basis, will continue to be deployed to help staff achieve research goals, and PhD bursaries provided to support areas of strength. We have attracted increased funding from sources that are highly competitive (e.g. BHF, NIHR, Diabetes UK, BBSRC/CASE, MRC, and EU) for both postdoctoral and postgraduate research and as Principal and Co-Investigators. Bidding for research funding through third-stream activities such as Knowledge Transfer Partnerships (KTPs) will continue. To further enhance research income, our researchers are encouraged to submit more high-quality applications per annum, with time allocated via appraisal and outcomes monitored; funded sabbaticals will support grant writing and we will continue to fund grant writing workshops. An internal Peer Review College was formed in 2014 to strengthen grant writing skills. Together with fostered collaboration, these approaches aim to increase award success; the increased funding since 2014 demonstrates that our strategy is working.

Networking and collaboration are also important to our success. We aim to enhance internal links through existing mechanisms including networking events and research days, our RISE Academic Leadership Academy encompassing invited speakers and action learning sets, interdisciplinary research seminar series led by the research Themes, and pump-priming monies targeted to foster interaction. Furthermore, collaboration across the disciplines between Unit researchers, engineers, mathematicians and computer scientists is and will continue to be enabled through the following mechanisms: (i) consideration of interdisciplinary activities when allocating QR monies to studentships and development funding; (ii) integration of research days between UoAs/diverse research Centres; (iii) management of research (e.g. Research Committee/Funding Committee) at an interdisciplinary level; (iv) co-ordinated events to bring postdoctoral and postgraduate researchers together from across the disciplines; and (v) further integration of equipment resource to foster interaction. Collectively, these strategies aim to heighten blue skies

and applied research to increase impact and capacity.

IhSHA has **excellent links with many external partners and universities** (see ICSs, Section 1.3 and Section 4) and these will continue to be fostered through existing mechanisms. For example, staff development funds will support collaboration to facilitate innovative, high-quality research with investigators at hospitals, companies, universities, and research institutes nationally and internationally that aim to promote impact. CAHSCR has been successfully engaging in interdisciplinary research for many years through development of research involving health professional disciplines (e.g. medicine, nursing, physiotherapy, paramedics) and social sciences (sociology, health economics, psychology). This work has included a focus on implementation and improvement science and interprofessional/integration research. Collaboration has involved industry and universities across South London, with others in applied nursing and therapy research facilitated through the NIHR CLAHRC/ARC. CAHSCR aims to build on these collaborations to develop new networks, particularly with NHS partners and other researchers. The Unit's research Themes have established local, national and international links and will be the engines to drive future collaborations. Funding for collaboration between University partners in the London area has been achieved through pump-priming partnership grants for joint studentships (e.g. two training partnerships with Brunel University London). Similar funding will continue to provide interactive projects between partners. Collectively, such interactions and structures across the Unit, together with those existing and in development with external organisations will drive further blue skies research/research with impact over the coming decade.

Facility upgrade has been well-supported by the University through a sustained re-build and investment programme (Section 3). To support UoA3, available monies will be further channeled into facilities to support leading experimental and applied work in biomedicine, nutrition, pharmaceuticals, and health improvement. Public engagement is an important part of our activities (Section 4) and we aim to build on existing strengths. The Centre for Public Engagement, based in CAHSCR, is a recognized leader in public/patient involvement in nursing and health research and provides a range of support, including access to patient expertise to guide research design and conduct through the Patient Experience Network. IhSHA contributes considerably to public understanding of science through open days and 'Café Scientifique' meetings and events in the new Science Outreach Centre and off site using our innovative 'Labs in Lorries' (Section 4). Collectively, we are well placed to build on our public engagement agenda through the further use of these facilities.

1.2.4 Open Research and Ethical/Regulatory Frameworks

The Unit complies with our institutional open access policy, ensuring that outputs are freely accessible in line with HEFCE policy, funder, and REF guidelines. Monitoring also ensures compliance with funder requirements. Making outputs widely available reflects our commitment to producing research with the potential to drive significant economic, social and cultural impact. All outputs are available through the University's Research Repository to achieve a **Green open access environment as a minimum**. Additionally, University (including via RCUK) and QR funds are used to **support Gold open access** for papers accepted for publication in online journals when it is a funding requirement, and also when Gold access is deemed to bring additional benefit but is not necessarily a requirement; applications for the latter are reviewed by a funding panel on a case-by-case basis. Examples of Gold open access publications feature throughout this submission (34%, 72 out of 214 submitted outputs). The Unit complies with the University's policy on **data sharing and management**, which aligns with that of RCUK; data are also made available as supplementary files to manuscripts wherever possible or through other databases. Collectively, these mechanisms aim to promote a culture within the Unit which supports transparency of research and replication of data in research.

Through ongoing training and KU's subscription to a wide range of resources, academic staff and other researchers are actively supported in the many aspects of research ethics, the reproducibility of research, research integrity, intellectual property, regulatory procedures for working with human tissue, health and safety, and researcher supervision and development. These frameworks, which

enable and **support a rigorous and integrity-driven research culture**, are considered further under 'People' (Section 2).

1.3 Unit Impact

Research conducted within the Unit is diverse and multidisciplinary. Our needs-based research has led to extensive impactful interactions with policy makers, regulatory bodies, government agencies, professional bodies, practising healthcare professionals and third-stream partners (see also Section 4 and ICSs). **Our strategy has been to develop and nurture associations facilitating long-term, productive, relationships**, which extend well beyond initial research-based interactions, to enable us to more **effectively translate our research to business, professional practice and policy**.

Our agenda to build future impact is underpinned by an emphasis on, and growing appreciation for, the value and routes to impact, alongside the widening of our research base and the continued development of impact support structures. These structures are provided by Research, Impact and Business Development Managers from the Research, Business and Innovation Directorate, and by local Impact Champions (**Naughton** and **Tuffrey-Wijne**). Examples of procedures to enhance impact development and evaluation include: (i) competitive allocation of internal funds (e.g. studentships, first grants scheme); (ii) peer review of all grant proposals; (iii) routine collation and monitoring of research activities including impact (including use of impact tracking software); and (iv) impact training and 1:1 staff support.

Impactful research will continue to be driven forward by responding to sector needs and opportunities within the basic sciences and healthcare. These include commercialisation and licensing of intellectual property (IP) (the University has a Contracts Coordinator and retains the services of Marks & Clerk and UCL Business as IP advisors), pursuing Knowledge Transfer Partnership (KTP) projects, and grants to facilitate the translation of research to the commercial and healthcare sectors. Impact strategies are considered for all new grant applications. All substantial internal investment decisions (e.g. studentships, PDRAs, facilities and sabbaticals) also involve consideration of routes to impact. In parallel, our collaborative research activities with government and non-government bodies (Section 4) help enable increased impact through involvement in policy/process change.

As well as enabling the capture of impact through the identification and tracking of potential IP exploitation opportunities, sustained contact with stakeholders will continue to be achieved by on-going interaction between academic researchers and partners, augmented by business development managers acting as conduits following meetings and networking events. The Unit provides seed funding that staff and research partners can deploy to test and develop products and services emerging from the research.

In addition, we have a **longstanding programme for public engagement and enhancement of the awareness of science**, which arose from our applied research in healthcare and medical sciences. We have recently (2016) built a new **Science Outreach Centre** and have taken delivery of two state-of-the-art portable laboratories ('**Labs in Lorries**') (total ~£3M), which collectively enable us to engage the public, schools and colleges in our STEM-based research and education, both on- and off-site (Section 4). Furthermore, our **Centre for Public Engagement** (led by **Chambers**) was established in 2013 to develop excellence in public and patient involvement and engagement in health, social care and education, disseminating this work through an annual conference.

1.3.1 Relationship between the Unit's approach to impact and the submitted case studies

The collaborative route, through which successful research proposals are developed into long-term relationships, has led to several ICSs within the Unit, across both Centres. Additionally, in CAHSCR, our extensive collaboration with practising health professionals, professional bodies, NHS organisations and government agencies has led to substantial impact on professional

practice and health services. Here the relationship between each of our submitted ICSs and our approach to impact is summarised:

- (i) **Petróczi**, working in collaboration with WADA through her lead role on the Expert Group on Doping Prevalence, has further developed needs-based research into transformational changes to reduce doping in elite sports. The development of a novel, cost effective survey-based tool, a set of recommendations for recording and reporting doping prevalence to improve data quality, and a new multi-method framework for synthesis of evidence for doping behaviour have positively impacted on WADA's policies and practices, and indirectly impacted data recording and reporting practices in the global anti-doping community [ICSUoA03Petroczi7; **Protecting Sport by Improving the World Anti-Doping Agency's Capability for Assessing Doping Prevalence**].
- (ii) A further illustration of impact derived through collaborative projects, in part, arose from **Naughton's** role as Academic Policy Advisor on the Government Chemist Programme Expert Group as part of the National Measurement Office of the Department for Business, Innovation and Skills. These research and policy activities in food safety led to his appointment as Chair of the External Review Working Group of the European Food Safety Authority (EFSA). This group (2009-2015) audited the scientific activities of EFSA leading to significant changes in procedures and the quality of scientific outputs [ICSUoA03Naughton6; **Improvements to the procedures, capabilities and practices of the European Food Safety Authority and the UK Government Chemist Programme**].
- (iii) **Jones F's** long-term collaborations with HEE (East of England, London), NHS organisations (e.g. UCL Hospitals, St Georges' Hospital, King's College Hospital), Welsh government and Northern Ireland Health and Social Care Trust has enabled the spread and reach of Bridges self-management beyond stroke to become an approach now used across multiple healthcare settings, reaching patients with complex acute and long-term conditions such as neuromuscular disease, brain injury and major trauma. As demonstrated in the ICS, more than 5,000 NHS staff have received training and demonstrated changes in how they support self-management [ICSUoA03Jones3; **Bridges: advancing the spread of self-management support across acute and long-term healthcare settings**].
- (iv) A desire to help ameliorate chronic joint pain led **Hurley** to evaluate the clinical and cost benefits of exercise, patient education and self-management strategies to support rehabilitation. As with other submitted ICSs, the programme has a component centred on patient education whereby people learn about the problem, what might cause it, why they experience pain, and simple ways to cope and self-manage their condition. This further example, illustrating CAHSCRs patient-centred approach to research, led to wide uptake of **Hurley's** innovative rehabilitation programme for chronic joint pain among Health Science Networks; it is now recognised in the NHS Long-Term Plan (2019) [ICSUoA03Hurley1; **Enabling people to ESCAPE-pain from Osteoarthritis**].
- (v) The patient-centred approach was also utilised by **Chambers** in research enabling healthcare professionals to improve lives of mental health patients. Initially stimulated by a KU Enterprise Award, the research developed a validated Therapeutic Engagement Questionnaire enabling robust monitoring of registered nursing activity both in terms of quality and quantity. This directly led to: (i) improved quality of care and the use of technology; (ii) achieving parity of esteem between mental and physical health; and (iii) improved outcomes for people with mental health problems through high quality services that are accessible to all [ICSUoA03Chambers5; **The Therapeutic Engagement Questionnaire: a tool to quantify and give recognition to registered mental health nursing therapeutic engagement activity**].
- (vi) In-depth research into the healthcare needs of people with intellectual disabilities, especially for palliative care, led **Tuffrey-Wijne** to effect changes in: (i) policy; (ii) practice of bodies providing palliative care; and (iii) practice of educators in this field. The overall holistic approach has benefited end users, family and carers in addition to the recipient of palliative care [ICSUoA03TuffreyWijne4; **Transforming policy and practice in palliative and end-of-life care of people with intellectual disabilities**].
- (vii) Finally, close engagement with NHS general practitioners, managers and workforce development agencies led **Drennan** to investigate the value to the NHS of employing

Physician Associates in primary care and then secondary care. This research, demonstrating their clinical safety and cost effectiveness, has been used by the UK government, Health Education England, Health Education and Improvement Wales and NHS employers to increase the education and employment of Physician Associates resulting in increased numbers of Physician Associates to address medical shortages, increased income to universities, as well as maintaining good patient experience [ICSUoA03Drennan2; **Addressing the UK doctor shortage: Evidencing the clinical safety and effectiveness of physician associates leads to increased numbers in the NHS to address UK doctor shortages**].

2. People

The People Strategy of the Unit is guided by its commitment to equality and diversity and inclusion (EDI) for both staff and research students. KU was one of the first of only 15 institutions to be awarded (2015, renewed 2019) a **Bronze Race Equality Charter**. In 2014 the University won **The Guardian Award for Diversity Initiative** for a project that aimed to mainstream EDI into academic career progression. In addition, the School of Life Science Pharmacy and Chemistry, home to lhSHA staff, has achieved an **Athena Swan Bronze Departmental Award** (2018) in recognition of its commitment to advancement of gender equality in academia. SGUL, the partner institution for our HSCE faculty and home of CAHSCR holds an **Athena Swan Silver Award**. A diverse staff base within the Unit is supported through recruitment and promotion mechanisms that are informed by diversity data and progress/target alignment is monitored by the EDI unit. To ensure that EDI is embedded within the Unit structures, EDI Champions also exist within each Faculty.

2.1 Staffing Strategy and Staff Development

We aim to continually develop an inclusive and supportive environment to nurture and attract future research leaders. Our approach serves to ensure the vitality and sustainability of our research and impact base through recruitment, retention, and development of high calibre academic staff. Planning ensures retirements/resignations do not disrupt existing operations while also offering scope for quality enhancement and renewed research thrust. **Since 2014, the Unit has benefited from appointment of 48 new Category A staff**, many strategically selected for their research profiles thus increasing research capacity and sustainability within the Unit. **New staff include, in lhSHA** (Table 1): Prof **Aldabbagh** (DDDP Theme; previously Senior Lecturer, NUI Galway), and Prof **Dorak** (CR; previously Head of Health Sciences, Liverpool Hope University) who was appointed to lead the new School of Life Sciences, Pharmacy and Chemistry, and Dr's **Bear** (DDDP; previously Ramsay Memorial Research Fellow, UCL), **Buxton** (DCP; previously Senior Research Associate, UCL), **Chioni** (CR; previously Research Fellow, QMUL), **Elbediwy** (previously Researcher, Francis Crick Institute), **Gaymes** (CR; previously Lead Investigator, KCL), **Mackenzie** (DCP; previously Research Fellow, UCL), and **Morgan A** (DDDP; previously Research Associate, KCL). **In CAHSCR** (Table 1) new staff include: Prof **Harries** (I&IMP; Associate Dean Research; previously Head of Clinical Sciences, Brunel University London), Prof **Quinn** (ECCR; previously Associate Dean for Health & Medical Strategy, University of Surrey), and **Coxon** (IHW; previously Senior Lecturer, King's College London (KCL)). Collectively the new research-focused appointments have bolstered expertise and capacity and sustainability across the research Themes in areas including pharmaceuticals, genetics, basic biomedical science, disease mechanisms, and applied health research and practice.

We have built and sustained a critical mass of academic staff in areas of strength as reflected in this submission. The Unit ensures that it has a **sustainable mix of senior and junior staff** and that the career development of all staff is **supported through personal development plans**. To illustrate the staffing mix, this submission comprises **19 Professors, 21 Associate Professors, 34 Senior Lecturers, 12 Lecturers and 6 independent Research Fellows/Associates**. The submission comprises 40 male (43%) and 52 female (57%) academics, considerably above the STEMM benchmark for females (41%); 21% of staff are black and minority ethnic and 57% of staff are age 50 or younger. In addition, during the review period the Unit has

hosted and additional **36 Research Fellows/Research Assistants** as well as a vibrant pool of PhD and MScR/MRes students (below). We currently have **14 (post-01/08/16) early career researchers** (ECRs). Often, previous staff members retain Unit collaborations and Emeritus Professors continue to build their research in the Unit providing expertise and mentorship for junior staff.

The priorities when appointing new research-focused academic staff are international quality of their published research, fit to research foci, and (if appropriate to grade) evidence of success in attracting competitive research grants. Most new staff arrive with significant research expertise and are afforded time to enable research development. This is also the case for **ECRs** (e.g. **Bear, Buxton, Elbediwy, Lear, Mackenzie, Mellinghoff**) **who are important to the Unit's development and sustainability**. Our ECRs meet monthly and are assigned to a designated senior researcher to support their integration into the Unit and their development as scientists. **All new staff members are aligned with a research area (Theme)**, provided an academic mentor, REF QR monies for consumables and small equipment items, and free access to all facilities including centralized resources such as laser scanning confocal microscopy, instrumentation and NMR suites. ECRs are also supported to apply to the University's (~£10K) **first grants scheme**. In addition, within CAHSCR, staff are provided free access to the SGUL Medical School Library and the Clinical Research Facility. All staff are supported to apply for research grants, and ECRs are considered favorably when studentships/bursaries are allocated. The University provides training for project management and compulsory training for postgraduate student supervision. Furthermore, **comprehensive research and enterprise training exists for staff** with topics covered in the period including: KTP funding, Horizon 2020 briefing, the Global Challenges Research Fund, fast track impact, GDPR & research data, legal contracts & negotiations, Intellectual Property Rights protection, research management, ethics and publication masterclasses. Staff are further supported in the development of impact by the Impact Champions and the mechanisms detailed in the impact strategy (Section 1), which include **seed funding** to test and develop products and services emerging from the research. Specific training is delivered for compliance with the Human Tissues Act, HRA processes and ICH Good Clinical Practice as appropriate. Within CAHSCR, staff can also access the RISE Clinical Academic Research Leadership Academy led by **Harries** as well as appropriate training through SGUL and the CLAHRC/ARC to augment KU's provision. **Collectively, these approaches help integrate new staff and encourage research excellence at an early stage.**

Several specific schemes further serve to **promote EDI within the Unit**; these include the **Beyond Barriers Mentoring Scheme** for BME staff and female staff (12 mentees and 14 mentors in the Unit within this REF period), which aims to maximise potential, resilience, astuteness and confidence within these groups. In addition, six female staff within the Unit have attended the **Aurora Programme**, Advance HE's leadership development initiative for women. Additional examples of where EDI is embedded within Unit activities are: (i) flexible working; all academic staff within the Unit can work flexibly/remotely for at least one day per week, and for longer durations by arrangement with their Head of Department; (ii) evaluation and reduction of teaching workloads for staff with health issues to enable them to remain productive in research; (iii) equal career/promotion opportunities; (iv) funding for conferences/sabbaticals, and (v) access to internal funds to support research and impact, irrespective of staff FTE fraction. Importantly, staff that are involved in EDI-related decision making are required to undergo unconscious bias training. For the construction of this submission, the UoA co-ordinator (**Walker** and other staff involved in the selection of research outputs and ICSs were fully versed in the University's Code of Practice, and completed Equality Essentials and Unconscious Bias Training workshops (the latter part of specific REF training).

Research progress/career development is appraised against agreed targets. External activities (e.g. grant/journal reviewing, editing, policy committee work; Section 4) are considered vital to engagement with the broader research/impact base and are encouraged. All staff can apply for sabbaticals with priority given to those with demonstrable research outcomes. **Promotion** to Associate Professor or Professor is considered annually and is supported by international peer review with international research excellence the key criterion; since 2014 the Unit has seen

Unit-level environment template (REF5b)

several staff promoted at all levels, including nine current staff members to Associate Professor (**Ashrafi, El Nabhani, Elshaer, Halter, Hill, Le Gresley, Moir, Nikolettou, Snabaitis**) and five to Professor (**Boaz, Jones F, Kayyali, Price, Tuffrey-Wijne**). These mechanisms, together with appropriate recruitment of new staff ensures that the profile of the Unit is fit for purpose, particularly with respect to succession planning for research leadership and research management.

The University actively engages the **Concordat to Support the Career Development of Researchers** and performs Gap Analysis and Action Planning to ensure its successful deployment. Research Assistants are represented on the University's Researcher Career Development Group, participate in a Researchers Forum, participate in career development activities and are integrated into the academic framework to broaden their expertise. When academic appointments arise, researchers are encouraged to apply; several of our researchers have been successful in obtaining their first academic positions at the University (e.g. **Al-Kinani, Calestani, Polycarpou**) with others securing permanent research positions (e.g., **Brearley, O'Shea, Taylor F**).

2.2 Research Students

Since 2013/14, **93 students within the Unit have been awarded doctoral degrees** (plus 10 PhD by publication and 5 wholly overseas). In addition, 50 MScR/MPhil degrees have been awarded, together with a further 49 Masters in Research (MRes) in Clinical Practice within CAHSCR, part of the NIHR programme for integrated clinical academic careers until 2018, which have further supported research. Currently, **101** doctoral students and 16 MScR students are registered in the Unit across the two research Centres.

The Unit aims to provide an exemplary training, support and learning environment for its research students. Doctoral students are supported through externally funded industrial, charitable and RCUK research contracts (e.g. BHF studentships, Polycystic Kidney Disease Charity, GSK, NIHR and BBSRC-CASE awards) and competitively awarded internal funding. **Eighteen KU PhD studentships (including four Doctoral Training Alliance (DTA) studentships) and 37 internal PhD/MScR/MRes starter bursaries have also been awarded** during the review period, together with additional completion bursaries; continuing students who wish to self-fund their research degree are awarded a 10% reduction in tuition fee. The Applied Biosciences for Health DTA PhD studentships, funded by University Alliance, fall under the umbrella theme of "understanding and promoting healthy ageing" and connect researchers across the network of Alliance Universities. The Unit attracts self-funded PhD/MScR students and students who obtain funding directly from sources including their national governments e.g. USA, Nigeria, Denmark, Portugal, and The Czech Republic. The over-riding criterion used to appoint research students is academic strength. Students are supported through effective and structured training, informed by Research Council/QAA guidelines, that ensures their continued professional development.

Each research student has a first supervisor plus one or more other supervisors and support from the Director of Postgraduate Research Studies, **Barker** for IhSHA and **Coxon** for CAHSCR; **Coxon** is also the Training Lead for the South London NIHR (CL)AHRC, and **McRae** and **Coxon** are both NIHR training advocates for clinical academic careers. The University's Graduate Research School (GRS) operates a Code of Practice that closely aligns with that of the QAA that includes **annual progression reporting/mapping** and substantial report/viva at the end of year one. **Students in the Unit are aligned to Themes** (Table 1), are integral to one of the two Centres, and must actively engage in Centre/research area activities that include focus group meetings, journal clubs, internal/external research seminars/talks, and Unit/University Research Days where they must present their research. Students are also encouraged to engage in initiatives such as Vitae's 'Three Minute Thesis' (3MT) competition. The GRS provides **compulsory training** in core multidisciplinary/ transferable skills (e.g. ethics, intellectual property, personal development portfolio planning, thesis writing skills) and acts as a central point for further support. Additional online research training is provided via the Epigeum suite of training courses. Students can also demonstrate in undergraduate laboratory classes and training is provided.

Unit-level environment template (REF5b)

Collective training/personal development is assessed during Annual Monitoring using the Vitae Researcher Development Framework. **Research students are also financially supported through Unit** and University funding streams to present at national/international conferences. Unit research students attend the collaborative doctoral summer school held between KU, SGUL and Roehampton University. In addition to this in-house training environment, many students receive further support/training through collaboration with hospitals, companies, universities, and other institutes (Section 4). In addition to these structures/ processes, on-site support is also available for CAHSCR-based students from the Joint Research and Enterprise Office at SGUL/ St George's University Hospital NHS Foundation Trust. A Unit member sits on the University Research Ethics Committee, which provides guidance on student development for ethics procedures. In terms of **EDI**, research students gain (i) equal opportunity for bursary support; (ii) equal access to internal conference funding and Gold open access funding for PhD students irrespective of status (part-time, full-time, or otherwise); and (iii) registration extension to support research students experiencing health difficulties (evaluated through the Research Degrees Committees).

Research students are provided dedicated laboratory space within clusters of laboratories or large designated collaborative research spaces (e.g. within the new Integrated Research Laboratory or Clinical Research Facility) and individual workstations in communal postgraduate research rooms/suites to **foster interaction, collaboration and discussion**. The new Town House Project (completed 2020) incorporates extensive library and seminar facilities and provides further research-orientated space; in addition, students based in CAHSCR have direct access to the Medical School library at SGUL.

The need to do **research that is internationally competitive and impactful** is instilled through student support/training. This serves to deliver successful completions and publications, enabling students to move on to prestigious research posts thereafter (e.g. postdoctoral positions at Imperial College, University College London, University of Oxford, University of Sheffield). Our research students have been successful in achieving **prestigious awards** such as: the Geoffrey Phillips Analytical Science Award (2014), 3MT semi-finalist (2017); National Cancer Research Institute Award (2015); International Graduate Student Award from American Association of Pharmaceutical Scientists, Scholarships from the British Federation of Women Graduates (2017), Pharmacy Practice Research UK, and Royal Society of Chemistry.

3. Income, infrastructure and facilities

3.1 Research Income

There has been a **steady rise in research income** to the Unit over the period with income at ~£5.65M. This represents a 'like-for-like' **~4.3-fold uplift in funding** compared to ~£1.28M captured by the Unit in the previous REF period.

Research funding during the assessment period has been captured from highly competitive sources as detailed in REF4, including: the Royal Society, BBSRC, MRC, EPSRC, NIHR, EU ERASMUS, EU FP6/FP7, EU H2020, Wellcome Trust, The Royal Society for Chemistry, Diabetes UK, TSB/Innovate UK, GSK, Boehringer Ingelheim International GmbH, BRIGHT charity, BHF, WADA, LGC, DSTL (MOD), and Fight for Sight. Unit researchers have secured a total of 14 NIHR grants in the period. Support in kind includes acquisition of research equipment (e.g. two mass spectrometers and facilities for oral health research) and services. Beam time access at the ISIS neutron and Muon Source (UKRI) was £87k (REF4c). As indicated by the awards, our externally funded research supports both basic research and research with a translational focus, including those projects (e.g. NIHR, WADA, the IOC, Arthritis Research UK-funded) that have underpinned our seven ICSs.

The **Unit's strategy for generating research income** and diversifying source (as detailed within Sections 1 and 2) is broadly to: (i) support staff members (especially ECRs) with research grant applications through mentoring, sabbaticals, grant writing and impact workshops, and pump priming funds to generate preliminary data; (ii) perform internal peer review to further support the

Unit-level environment template (REF5b)

writing of high-quality research applications; (iii) manage staff work-loads to enable the writing of a greater number of high-quality applications; (iv) build on existing relationships with funders, including those with whom impact has been generated; (v) build on research and impact collaborations both nationally and internationally; and (vi) enable staff to successfully deliver on a research project once funding has been achieved through management of staff time/responsibilities. The enhanced award capture from diverse income source when compared with that reported in REF2014 demonstrates that our strategy is working. The approaches will therefore remain broadly similar for the next REF period. Income generation will be monitored at quarterly Unit meetings to ensure income generation aligns with sensible targets.

3.2 Infrastructure and Facilities

A significant proportion of the University's infrastructure development continues to be focused on the health, life and social sciences, with the Unit being a key beneficiary. In total, Unit research is conducted within four major facilities (buildings) at the two sites.

For IhSHA, one large facility (Eadweard Muybridge building, constructed 2001, £10M) incorporates research space (~1500 m²) that includes extensive modern synthesis facilities, instrumentation suites, physiology/biomechanics/blood analysis laboratories, biomedical laboratories, microscopy suites, and research student offices. A further facility supporting additional IhSHA research (~300 m²) houses separate modern suites for pathogen research, molecular microbiology/GM, tissue culture, natural products analysis, cell signalling, histology, immunology, and microscopy/image analysis. A new infrastructure development (2008/9, £20M) comprising 65 lecture/seminar/conference rooms has enabled other spaces to be re-purposed for research/teaching across the life/pharmaceutical sciences; these include a biotechnology/ molecular biology suite (2011/2, ~£1.1M), NMR suite (2010, ~£0.5M), several tissue culture facilities and further molecular laboratories (2009/10; ~£1.5M) totaling an additional ~300 m² for allied health profession and pharmaceuticals research. A bid for a new ~350 m² Interdisciplinary Research Laboratory was successful (2013/14, ~£2M). This new laboratory incorporates extensive tissue culture facilities (e.g. 10 tissue culture hoods), proteomic and biochemistry laboratories with new equipment, a sequencing room, a collaborative discussion space and a bioinformatics core. This recent addition that has expanded research infrastructure, complements pre-existing resource and provides extra research facilities and collaboration space.

In 2017 CAHSCR moved to new research premises; this move ensured the co-location of postdoctoral researchers and research students with senior researchers and clinicians. CAHSCR is located in the middle of a large hospital which brings benefits in terms of clinically related collaboration. It has facilitated joint learning (seminars and conferences), exchanges such as visiting appointments (e.g. Jarman from St George's Emergency Department) and several research-based collaborations that have helped drive impact (see ICSs).

Thus, funds from HEFCE/University initiatives (totaling over £8M in the last decade) have enabled sustained improvement of research facilities. Improvements comprising laboratory refurbishment and new build (above) housing major equipment include among other instrumentation 400 and 600 MHz NMR Bruker spectrometers, ICP-MS, ICP-AES, 3 x LC-MS/MS, 2 x GC-MS, laser infrared microscope, laser Raman spectrophotometer, X-ray diffractometer, high-resolution SEM (Zeiss), 2 x CLSM (including new Zeiss 800 LSM), flow cytometers/FACS, BodPod, protein synthesis equipment, and Ion-Torrent sequencer (**equipment acquisitions totaling in excess of ~£2.5M**). Equipment donations over the same duration valued at ~£0.5M include LC-MS/MS, MS/MS, incubators, microscopes, PCR and other instrumentation. All smaller items of equipment (e.g. nanodrops, fluorescence/luminescence plate readers, LiCor Odyssey Imaging system, Fluid imaging systems) are state-of-the-art and are replaced on a **rolling capital equipment programme**. Importantly, all academic research staff and other researchers have full access to the above facilities. There are no access charges for the use of large items of equipment (e.g. SEM/CLSM) unless specific project funding is held, enabling cutting edge research to take place even in the absence of a project grant.

Unit-level environment template (REF5b)

Substantial additional laboratory space and computational/engineering equipment exist elsewhere in the University and these are being developed to foster diverse and interdisciplinary work including that between Allied Health researchers, engineers, mathematicians and computer scientists. Unit members can also use the newly refurbished (2015) **Clinical Research Facility** (480 m²) incorporating six examination/treatment rooms and a sample processing laboratory, which benefits our clinically orientated research. Thus, considerable infrastructure exists to further expand research, collaboration, and impact. Unit scientists also have access to wide-ranging complementary state-of-the-art equipment at SGUL, through reciprocal research equipment arrangements.

In addition to the above core research facilities that support directly our research and impact (see ICSs) through enabling our basic and translational science, we have also built a new **Science Outreach Centre** and have taken delivery of two state-of-the-art portable laboratories ('Labs in Lorries') (total ~£3M). The mobile laboratories are equipped with interactive resources such as patient simulator robots, electrocardiogram, a range of microscopes and portable analytical instruments for studies in nutrition, forensic science and health sciences. These facilities, together with the Centre for Public Engagement based in CAHSCR, enable us to engage the public, schools and colleges in our research and education, both on- and off-site.

Governance and planning for research infrastructure and facilities is conducted through equipment user and planning groups. Within the Unit, core facilities are operated wherever possible to enable broad usage. Cohesion in the Unit's research and research Centres makes structured facilities planning viable, so that maximum benefit is gained from facilities and infrastructure resource. Finally, the University's New Town House project (~£50M, completed 2020) and adjacent to existing lhSHA facilities provide world class library and seminar space for researchers to work and collaborate.

4. Collaboration and contribution to the research base, economy and society

Because research can be actively enhanced through interaction, **collaboration remains important to the Unit's strategy**. Thus, we work to maintain and develop strong partnerships that underpin collaborative research. Specific mechanisms to achieve this are detailed elsewhere as they underpin our research strategy and are also relevant to staff development (Sections 1 and 2). Unit arrangements to facilitate the development of research projects with academic colleagues in other institutions, both in the UK and overseas include: (i) deployment of QR funds to support Unit staff attendance at research conferences, workshops and collaborative meetings; (ii) allocation of short research sabbaticals to support periods of collaborative work where required, particularly to pump prime novel ideas; (iii) time allocated to build and generate collaborative grant applications; (iv) monies for collaborative PhD studentships; and (iv) monies to support potential collaborators to attend the University for short visits, often as part of a seminar series.

4.1 External Collaborations within the Unit

A high proportion (91%) of outputs submitted for review include external collaborations. Collectively, these collaborations, which span all research Themes, serve to enhance the Unit's research by drawing on specific academic expertise, both nationally and internationally, to benefit defined research projects. This in turn promotes an external-facing collaborative research environment which advances opportunities for all Unit staff and associated research students.

Table 2. Co-authorships within the total pool of submitted outputs highlighting collaboration with **UK universities and other research institutes** (top 30 shown, excluding companies, hospitals and NHS Trusts) by lhSHA and CAHSCR staff. The number of collaborations shown is at the level of the organisation and not with individual research groups.

Total number of separate collaborations (counted per university/institutes): 330			
University	No.	University	No.
King's College London	44	Royal Holloway University of London	6
University College London	29	University of Cardiff	6
University of Oxford	17	Natural History Museum London	5
Imperial College	15	University of Leicester	5
Brunel University London	12	University of York	5
University of Southampton	11	Heriot-Watt University	4
St George's University of London	9	University of Liverpool	4
University of Surrey	9	University of Manchester	4
London School Hygiene & Trop Med	8	University of Nottingham	4
Queen Mary University of London	8	Loughborough University	3
University of Cambridge	8	Queens University Belfast	3
University of Leeds	8	Swansea University	3
University of Birmingham	7	University of Brighton	3
University of Warwick	7	University of Bristol	3
City University	6	University of Hertfordshire	3
Others (51 universities/institutes)			71

Table 3. Co-authorships identified within the total pool of submitted outputs highlighting **international collaboration** (top 20 countries shown) by lhSHA and CAHSCR staff. The number of collaborations shown is at the level of country and not research organisation.

Total number of separate collaborations (counted per Institution): 356 in 46 countries		
Country	No.	Example Institutions
USA	81	Howard Hughes Medical Institute; US Dept Agriculture; Universities: Oregon State, Harvard, Illinois at Chicago, Washington, Texas A&M
Australia	27	La Trobe University; Monash University; University of Queensland
Germany	26	University of Tübingen; Ludwig-Maximilians University Munich
The Netherlands	24	Leiden University; Utrecht University; Vrije University
Finland	22	University of Helsinki; University of Turku; University of Oulu
Spain	22	University of Granada; Bellvitge Biomedical Research Institute
Sweden	22	Karolinska Institute; University of Lund; Uppsala University
France	17	University of Angers; University of Perpignan; Paris Descartes University
Italy	16	University Hospital Genoa; University of Turin; University of Pisa
Denmark	11	University of Copenhagen; Aarhus University
Canada	7	University of Toronto; University of Western Ontario
China	7	Zhejiang University; Nanjing University; Wuhan Institute of Virology
Greece	7	Aristotle University; University of Thessaloniki
Ireland	7	NUI Galway; University Hospital Dublin; University College Dublin
New Zealand	7	University of Canterbury Christchurch; University of Auckland
Egypt	6	Cairo University; Minya University
Norway	5	Norwegian Institute of Public Health; Molde University College
Singapore	4	National University of Singapore, Agency for Science & Technology
Turkey	4	Istanbul University; Koc University
Switzerland	3	Geneva University Hospital
Others (26 other countries)	31	University of Graz (Austria); University of Lisbon (Portugal); Kyoto University (Japan); Ghent University Hospital (Belgium)

These academic collaborations are particularly strong with **15 universities proximal to KU in the South East of England, and a further 15 country-wide** (Table 2). In total, the submitted outputs highlight 330 output-specific collaborations across 76 UK universities and five other research institutions such as the Wellcome Sanger Institute and Natural History Museum London.

Wide-ranging international collaborations are also evidenced through the submitted research outputs. These are represented by 356 separate output-specific collaborations (measured at the institutional level) **across 46 different countries** (Table 3).

In addition, several **Unit members have Honorary posts** (e.g. visiting Professorial/research appointments) to facilitate national/international research collaborations in the basic and applied health sciences. These include those with universities in Australia (**Drennan, Hurley**), New Zealand (**Alany, Jones F**), Ireland and France (**Aldabbagh**), China (**Drennan**), Sweden, Germany (**Petróczi**), the USA (**Dorak**), Norway and the Netherlands (**Chambers, Hurley**), Brazil (**Chambers**) and the UK (**Busquets, Walker, Lawton**).

4.2 Relationship with Industry, the Public Sector, Economy and Society

The relationship of the Unit's research with industry, the economy, and the public sector is strong and is **fostered through active research collaboration and translational research activities** (Section 1, research outputs, and ICSs). As evident in the outputs submitted, **49 links with NHS partners exist**, augmented through additional work with medical schools. There are **collaborations with NHS institutions and clinicians in 28 different NHS Foundation Trusts across the UK as well as primary care and care homes**, including with St George's Hospital Trust, particularly through CAHSCR, and others including Kingston Hospital (**Arrigoni, Ashrafi, Modjtahedi**), Croydon University Hospital (**El Nabhani, Kayyali**), Barts (**Harries**), Royal Marsden and Royal Surrey County Hospitals (**El Nabhani; Modjtahedi**), New Victoria Hospital (Kingston) (**Ashrafi**), the Royal London (**Chioni**), St Mary's, and Guys and St Thomas's (**Coxon**).

Collaborations exist with NHS mental health, community and ambulance trusts, primary care and third sector health and social care organisations (e.g. care homes) in diverse research areas including dementia care, out of hospital urgent and emergency care, cardiac care, health and social care of people with learning disabilities, health and social care of older adults living at home, workforce development, and patient attitude (between staff including **Drennan, Chambers, Jones F, Quinn, and Tuffrey-Wijne**). Collectively these relationships have and continue to enable researchers to access patients/patient samples and work with clinicians, linking needs-based applied research to outcomes that benefit society. For example, work with the Croydon University Hospital includes an Innovate UK-funded project (OPTIMAL; £197K) linked with Exus Ltd (Section 1), and collaborations with several NHS ambulance services, include two major NIHR HTA-funded trials in out-of-hospital cardiac arrest (PARAMEDIC, PARAMEDIC-2) and a BHF funded study (~£107K) exploring use/impact of the prehospital electrocardiogram in heart attack patients (PHECG2).

Relationships with other national/international government organisations and agencies are wide-ranging and include, for example, links with the Royal College of Midwives and BirthChoiceUK (**Coxon**), AHVLA (**Fielder**), WADA (**Petróczi**), UK Sport (**Petróczi**), EFSA (**Naughton**), LGC Ltd (**Le Gresley, Naughton**), DSTL Porton Down (**Karlyshev**), MRC Clinical Sciences Centre (Hammersmith) (**Arrigoni**), NHS England (**Tuffrey-Wijne, Chambers, Quinn, Drennan**) and the Institute for Cancer Research Sutton (**Chioni, Modjtahedi**). Collaboration with industry is also strong, particularly within Isha (e.g. **Alany, Aldabbagh, Ashrafi, Barker, Busquets, El Nabhani, Fielder, Karlyshev, Kayyali, Le Gresley, Moir, Modjtahedi, Naughton, Petróczi**), spanning many sectors, to support innovation, especially that which aims to deliver impact. **Examples of collaborative projects/advisory work done in the period within industry and/or continuing within the Unit include** those with UCB Manufacturing (drug development), Vantix Ltd, TwistDX (microbial detection), GSK (oral health/drug development), Exus Ltd (innovation management), Boehringer-Ingelheim (cancer therapeutics), Tottenham Hotspur Football Club (post-match recovery), Profeet Sports Lab (gait and foot analysis for injury patterns), LGC Ltd (analytics and standards), Observia (personalized medicines), Mast Carbon International,

Unit-level environment template (REF5b)

Alleva Animal Health and Immodulon Therapeutics (immunotherapy). Collectively, these valuable interactions serve to increase the vitality, reach and impact of our research on business and broader society.

4.3 Peer Review, Advisory Roles, and Public Engagement

Unit staff are recognised for their scientific expertise and **peer review for over 70 funding bodies** that include: National Science Foundation (USA), CRUK, The Grant Agency of the Czech Republic, Wellcome Trust, Leverhulme Trust, The Nuffield Foundation, BHF, Stroke Association, Arthritis Research UK, NIHR, BBSRC, EPSRC, MRC, and the EU. Furthermore, **staff have served on 47 funding committees/panels** (Table 4) within this REF period. Prominent examples include: **Aldabbagh**, member of the EPSRC Associated College; **Hurley**, Chair of Arthritis Research UK Fellowship Committee; **Walker**, expert panel member (Seeding Drug Discovery), Wellcome Trust; **Boaz** and **Drennan**, members of the NIHR Health Services and Research Delivery Board, NIHR research for Patient Benefit (London) panel and NIHR Programme grants for applied research; **Harries**, member of the NIHR Prioritisation Committee C and NIHR/HEE Clinical Doctoral Research Fellowships Panel; and **Petróczy**, Assessor/Advisory Board Member for the Commonwealth Scholarship Commission. **Harries** and **Chambers** have also been appointed REF2021 sub-panel members for UoA3.

Table 4. Summary statistics for contribution to the research base, economy and society.

Awards and Roles				
Prizes / Honours	41	Funding Panel Membership		47
Fellow of Learned or Professional Society	37	<i>Advisory (e.g. Professional and regulatory, NHS, Government, NGO)</i>		77
Journal Editorship	19	Conference	Plenary/invited	245
Journal Editorial Board Membership	64	Talks	Other	305

Staff members with advisory **Committee Roles** (77 roles in total; Table 4) have made/continue to make substantial contributions to the discipline in the review period. The more prominent contributions include: President of the Malacological Society of London (**Walker**); President of the Society for Applied Microbiology, Member of the Scientific Advisory Committee for Responsible Use of Medicines in Agriculture, Advisor to the Clinical and Laboratory Sciences Institute, and Member of the Parliamentary and Scientific Committee UK Antimicrobial Resistance Diagnostic Collaborative Task and Finish Group (**Fielder**); Chair of the WADA Expert Group on Doping Prevalence (**Petróczy**); World Health Organization European Advisory Committee on Health Research (**Boaz**); Clinical Director of NHS Health Innovation Network (South London AHSN) (**Hurley**); Vice Chair of Council and Chair of R&D Board Royal College of Occupational Therapists (**Harries**); Chair of the External Working Review Group of the European Food Standards Agency (EFSA), Scientific Expert for EFSA, and Member of the Government Chemist Programme Expert Group (**Naughton**); Steering Committee Member at the Environmental Protection Agency, Ireland (**Busquets**).

Members of the Unit have also been involved in the organisation of over 40 conferences in the review period and have been **invited to speak/give plenary talks at 550 conferences and symposia in the UK and overseas** (Table 4).

Unit members hold **19 editorships and 64 editorial board positions on a range of international journals highlighting the Unit's expertise across the discipline**. Examples include: Parasites & Vectors (**Walker**, Section Editor/Board); Pharmaceutical Development and Technology (**Alany**, Editor-in-Chief); Current Drug Delivery (**Alany**, Board); Journal of Molluscan Studies (**Walker**, Associate Editor); Frontiers Journals (**Dorak**, Associate Editor); Genes and Immunity (**Dorak**,

Unit-level environment template (REF5b)

Board); Chemistry Central Journal (**Barker** and **Naughton**, Founding Editors/Board); Evidence & Policy (**Boaz**, Founding Editor); Health Expectations (**Chambers**, Associate Editor); Molecular Genetics, Microbiology and Virology (**Karlyshev**, Board); European Heart Journal (**Quinn**, Board); Journal of Advanced Nursing (**Drennan**, Board) International Journal of Oncology (**Modjtahedi**, Board); Oncology Reports (**Modjtahedi**, Board); Molecules (**Naughton**, Section Editor); Biomarkers, Psychology of Sport and Exercise (**Petróczi**, Board); and Microorganisms (**Snyder**, Board). All Unit staff members undertake peer-review for acclaimed international journals.

The above advisory positions have enabled Unit members to influence funding decisions, policy agendas, strategic priorities and development in a broad range of organisations in diverse sectors that include charities, government agencies, learned societies and other professional bodies, and industry. They also serve to highlight the diverse communities with which we interact. They provide for a rich sustainable research environment which addresses societal challenges, particularly those relating to complex issues pertaining to the improvement of health and wellbeing.

We actively engage the public and enhance the awareness of science and have built and developed enabling facilities that include a dedicated Outreach Centre, two 'Labs in a Lorry' and the Centre for Public Engagement (Sections 1.3 and 3.2). To date the 'Labs in a lorry' have attended over 100 individual events (e.g. Big Bang Fair, Festival of science, New Scientist Live), reaching well over 10,000 individuals, and the Outreach Centre supports numerous school events, Society events (e.g. Royal Society of Chemistry Schools analyst competition) and the Annual Civic reception (typically 13 talks, 40 stands, exhibitions and displays; ~400 attendees). We also run a monthly 'Café Scientifique'. Additional activities have included the Royal Society of Chemistry 'Spectroscopy in a Suit Case' and the National Science and Engineering Saturday Club. The Saturday Club, which gives young people aged 14-16 the opportunity to study science and engineering in a fun, informal, university environment was inaugurated at KU and has been running for four years in partnership with The Sorrell Foundation. Our experts are often interviewed by the media (e.g. BBC, Sky News), especially **Fielder**, a leading public speaker on infectious disease with longstanding research in zoonosis, hospital infections, and antibiotic resistance, who frequently contributes to print/broadcast on these topics, and more recently on Covid-19 (80 interviews/Q&A sessions on Covid-19 related topics done in the period). Other engagement examples include a behaviour study to impart healthy lifestyles and anti-doping educational programmes which helped to reduce smoking rates (involving 1,445 students) funded by the UK National Prevention Research Initiative (NPRI) and an anti-doping 'Safe You' project (funded by ERASMUS+) - delivered across five nations via a pan-European consortium - designed to reach the public raising awareness through online videos and is flagged by the European Commission as a 'success story' and a 'good practice example' (**Petróczi**).

Finally, **Medals, Awards, and Honours** (41 within the review period, Table 4) received by Unit researchers include The Queen's Honours MBE (**Drennan**, **Jones F**), International Trial of the Year Award (Society for Clinical Trials, **Quinn**), Royal Society of Chemistry Exceptional Service Award (**Barker**), Fujitsu Award for Outstanding Research Impact on Health and Wellbeing (**Quinn**), and the Royal Society of Public Health Award, NHS England National Innovation Accelerator Fellowship for ESCAPE-pain and Joint Pain programmes, and British Society of Rheumatology Best Practice Award (**Hurley**).