Institution: University of Brighton

Unit of Assessment: A3 Allied Health Professions, Dentistry, Nursing and Pharmacy

a. Overview

The University of Brighton (UoB) has a sustained history of returning healthcare research within the current UoA[3] subject boundaries, having done so since 1992. We pursue research across the full range of the 'translation continuum', from fundamental laboratory based pharmacy and biomedical science through to intervention development and the translation of research findings into practice.

Since 2008, the UoB has moved towards managing research in three broad areas: *Arts and Humanities*, *Social Sciences*, and *Life, Health and Physical Sciences,* supported by a Director of Research Development who reports to the Pro-Vice Chancellor (PVC) Research. Supported by the University's Research Office, this team is responsible for the leadership and strategic oversight of research developments that include: the Brighton Doctoral College (BDC), the Research Concordat, the management of research sabbaticals, Research Innovation Awards, economic and social engagement, and a university-wide programme for early career researchers (ECRs).

The cross-institutional health-related research returned in this UoA (including that involving the joint Brighton and Sussex Medical School) transcends school boundaries and presently focuses on four themes: *Applied Clinical, Healthcare Technologies, Chronic Diseases, and Growth, Development and Ageing*. Each is led by at least one professorial researcher and is sustainable in its own right, although significant knowledge and researcher interchange exists between them (see research strategy).

Strong international networks support our research base, with over 200 outputs resulting from research collaborations with more than 175 institutions in more than 27 countries. We have been awarded more than £14m in direct grants and research contracts from more than 65 sponsors. Industrial collaboration (>20 principal sponsors) and partnerships with other users/beneficiaries are fundamental characteristics of our research culture (see Impact Template and Impact Case Studies). We have received significant support for our research environment from the UoB since 2008, including a new 8,500m^2 Biomedical Sciences building.

Collectively, these developments have enabled us to support a thriving doctoral student base (more than 80 completions within the assessment period) together with a considerable expansion of our specialist research equipment base, notably in the areas of human movement, postural analysis and biomedical science.

Our researchers play key roles in shaping international and national health research agendas through strategy and advisory committee work for the European Union (EU), RCUK and third-sector organisations (for example, through directorship of the NIHR RDS South East, being a research leader for the Chartered Society of Physiotherapy, directorship of the Allied Health Professions Research Network and membership of the BBSRC Basic Bioscience Underpinning Health Strategy Panel).

b. Research strategy

Our research strategy emphasises health research that addresses government healthcare challenges to improve both length and quality of life to provide demonstrable societal and professional benefits. It is predicated upon our drive to grow research capability across all areas of our health research base, especially within those disciplines (for example, physiotherapy, pharmacy, occupational therapy and podiatry practice) where there exists a tension between professional and research activities. Four strategic principles govern the research we conduct and the way we undertake it:

- We link basic scientific discoveries to practice and focus our research efforts on selected healthcare challenges (reflected in our themes). These areas match closely a subset of national and international research priorities that we both shape and respond to (section e).
- We foster cross-disciplinary research with institutional funding to promote research in areas we identify as ripe for exploitation (see *Strategy for future research excellence*).

- We close the loop by feeding back appropriate patient and public experience into the selection of new research problems (for example, physiotherapy patients helped develop an RfPB-funded study on low back pain. They serve on the project steering group, as participants, and support dissemination).
- We are committed to delivering research with demonstrable societal benefit through partnership with others (REF3a).

Evidencing success: our achievements over the assessment period: The strategic aims reported in our RAE2008 submissions have been achieved and have resulted in significant breakthroughs (see *Main achievements by research theme*). We have exercised strategic control over our research portfolio for two decades and, as a result, fundamental research achievements reported in our past RAEs inform our impact case studies and template in this census period (for example, our DTI/LINK-funded research into novel biomimetic coatings that generated novel outputs in RAE2001).

Main achievements by research theme:

Applied clinical members: MOORE (lead), SCHOLES (lead), BRYANT, CROSS, LEACH, MANDY, OTTER, RIDEHALGH, SADLO, WALLER. Research focuses on neuromusculoskeletal function and dysfunction and also on acquired nursing competence. *Key achievements:* (i) demonstration that, despite remarkable improvements in treating rheumatoid arthritis, evidence-based, patient-centred interventions remain urgently needed for the treatment of foot pain in this group [OTTER,1]; (ii) provision of evidence that the use of individualised stroke self-management intervention is acceptable and drives changes in self-efficacy [MANDY, 2]; and (iii) identification of significant deficits in the ability of nursing students to manage patient deterioration in simulated clinical settings [SCHOLES,1].

Healthcare technologies members: SANTIN (lead), METCALFE (lead), JAMES, LLOYD, SANDEMAN. Primary focus on multiple aspects of material-tissue interaction within a healthcare context (for example, the production of bioactive scaffolds, the application of nanotechnology to materials and the selective removal of toxic substances from body fluids). Research direction focuses on the design of intelligent biomaterials. *Key achievements*: (i) demonstration that a scar-reducing agent (M6P) enhances nerve regeneration and early stage functional recovery [METCALFE, 2]; (ii) demonstration of enhanced chemoembolisation efficiency using a novel combination drug device for locoregional drug delivery for the treatment of pancreatic cancer [LLOYD, 2]; and (iii) demonstration of enhanced removal of cytokines from blood plasma by novel mesoporous carbide-derived carbons [SANDEMAN, 2].

Chronic diseases members: BONE (lead), RUSSELL (lead), DAVEY, FERNANDEZ-REYES, JACKSON, JONES, LUKASHKIN, MABLEY, MUKHOPADHYAY (submitted to UoA[4]). Chronic disease researchers study a spectrum of disorders, including addiction, diabetes, hearing loss and podoconiosis. *Key achievements:* (i) the first demonstration that enteroviral proteins are commonly found in the islets of recent-onset type 1 diabetes (T1D) patients, but only rarely in normal controls, strongly suggesting a causal link between enteroviral infection and development of T1D [BONE,1]; (ii) the first metagenomic study linking bacterial ability to metabolise conjugated bile acids with the colonisation of the human gut by beneficial microbes [JONES, 1]; (iii) the first report that sound recognition is key to successful mating in the mosquito responsible for the majority of malaria deaths annually, a discovery which opens up entirely new potential routes for control of this disease vector [RUSSELL, 3]; and (iv) the first nationwide mapping of podoconiosis across Ethiopia (657 districts and 130,000 individuals sampled) [DAVEY,1].

Growth, development and ageing members: FARAGHER (lead), RAJKUMAR (lead), BACHTARZI, BUSH, OKORIE, PATEL, ROGERS, SMITH, YEOMAN. Researchers study fundamental mechanisms of growth, development and age-related decline. *Key achievements:* (i) identification of a genetic variant (rs9939609) that correlates with children consuming more food [ROGERS, 1]. This finding indicates a direct role for the FTO locus in regulating dietary intake and thus driving substantial changes in BMI across the life course; (ii) published the first study showing that cardiac dysfunction may be specifically associated with abnormalities in extra-skeletal calcification (for example, OPG) and disordered phosphate metabolism [RAJKUMAR, 2]; and (iii) the first demonstration that entry into replicative senescence causes human vascular smooth muscle cells to turn into osteoblast-like cells, driving vascular calcification [FARAGHER, 2].

Thus, as planned in RAE2008: (i) our *Healthcare Technology* researchers have developed an increasing focus on translation of knowledge to the clinic in partnership with the medical device industry through the use of natural biomaterials to promote wound healing and novel coating technologies; (ii) researchers in the *Chronic Diseases* theme have collaborated with colleagues in *Healthcare Technologies* in new programmes of work examining the role of novel molecular scaffolds in promoting growth and differentiation (for example, through a BBSRC-CASE award with Porvair); (iii) our work on the ALSPAC study continues to contribute to understanding of dietary health risk factors in children whilst we continue to contribute new understanding to the field of ageing through the study of cells from patients with ageing disorders within the *Growth Development and Ageing* theme; (iv) the chemical biology of natural products that have anti-ageing or anti-carcinogenic properties remain a focus of the *Growth Development and Ageing* theme, as is work with ultra-long-lived organisms such as the Arctic quahog; (v) researchers in the *Applied Clinical* theme have significantly furthered understanding of musculoskeletal patients' experiences of treatment and the therapeutic encounter; (vi) in the fields of physiotherapy, osteopathy and podiatry, user focus and the appropriate use of mixed methods is embedded in our clinically applied research; and (vii) the use of standardised data collection in healthcare practice for both osteopaths and for physiotherapists working in the private sector has been taken up and disseminated through PhysioFirst and by the General Osteopathic Council.

Engagement with national and international priorities and initiatives: Our staff shape national and international research priorities (for example, through the work of MOORE on setting the research agenda within physiotherapy, that of BONE on the Type 1 Diabetes Research Agenda Roadmap for the UK, FARAGHER on the health research strategy of the BBSRC and SANTIN for the European Technology Platform on Nanomedicine). The overwhelming majority of our individual research awards can be mapped directly to the strategic priorities of both the research councils and to those of the third sector (for example, our work on the neurobiology of incontinence was selected for funding as part of a joint AgeUK-BBSRC call for more fundamental research in this area). Our work in *Healthcare Technologies* is a response to the needs of both the Technology Strategy Board and the European Union. Our expertise in the study of musculoskeletal dysfunction has allowed us to respond to the research needs of the NHS (through the NIHR), the General Osteopathic Council and the Chartered Society of Physiotherapy. Our expertise in ageing research is recognised internationally (for example, FARAGHER by the US Alliance for Aging Research) and our work on podoconiosis (led by DAVEY) led directly to the condition being recognised by the World Health Organization as a neglected tropical disease.

Promoting an active research culture: Interdisciplinary academic collaboration is a distinctive feature of our research culture. Researchers who would often be housed in separate departments or buildings (for example, cell biologists, analytical chemists and practicing pharmacists) have shared space and ideas at UoB for over 20 years. Thus our work (for example, in biomaterials and biosensing) is intrinsically more multidisciplinary than is the norm in single subject environments and this is strengthened further by cross-institutional research 'sandpits' that promote collaboration between diverse communities of practice. This academic atmosphere is enriched by our Doctoral College as well as by wide and varied weekly seminars covering our research themes, journal clubs and subject specialist meetings linking research activities to our teaching provision. In turn, our research culture is supported by our staff development strategy.

In line with the career training programme initiative for Nurses, Midwives and Allied Health Professionals, we have developed an MRes programme that will facilitate the development of the next generation of independent clinical researchers. Competitive external funding for five internships and 36 MRes Clinical Research places is already secured. We jointly fund PhD places with the NHS and over the next five years we will invest in seven post-doctoral NHS secondees. We collaborate with our local chief pharmacist (via a dedicated NHS joint appointment) to allow NHS pharmacists to develop their research skills and we develop research questions based on the clinical needs and experience of these professionals.

Development, promotion and dissemination of our research: In addition to traditional academic dissemination routes, we deploy audience-orientated mechanisms that allow us to disseminate for awareness, understanding, support or action as appropriate. Our university Marketing and Communications office targets information to the press and media specifically to

inform public opinion (eg REF3b[3]). When disseminating for understanding it is our practice to distribute an executive summary to our study participants (supplemented with conferences and leaflets). Other examples of dissemination for understanding include FARAGHER's role as scientific advisor for the *Who Am I?* exhibition at the Science Museum in London and JACKSON's role developing public communication for the British Association for Psychopharmacology. Examples of research dissemination for support and action are given in the impact cases linked to BONE and SMITH, respectively. Peer-to-peer dissemination is covered in *Collaboration and contribution to the research base*.

Ongoing multi-format dissemination mechanisms include our formal research networks and roles in learned societies (for example, MOORE directs the Allied Health Professions Research Network, which has 22 research hubs and is funded by the Chartered Society of Physiotherapy with donations from COT, BDA, BIOS, CSLT, SOCP and SOR). UoB also developed and hosts the National Council for Osteopathic Research that exists to grow research capacity and capability and disseminate evidence to the osteopathic profession.

Strategy for future research excellence: UoB's strategic plan 2012–2015 recognises health as a cornerstone of future institutional endeavour and envisages 'Partnerships for Health' encompassing research, professional formation and critical practice by the health professions. As part of a broader restructuring to deliver this plan (projected to take place 2014–2015), UoB has proposed the formation of a single Centre for Research and Development in *Life, Health & Physical Sciences* that will support our strategic principles and enhance our ability to promote multidisciplinary translational research. Within this new framework we will prioritise the following research whilst remaining responsive to new discoveries and opportunities:

Applied clinical: A multicentre approach taken to investigate the potential for parallel combination therapy to be beneficial in early rheumatoid arthritis. Existing wheelchair designs will be improved in collaboration with industry, including the development of new hybrid vehicles.

Healthcare technologies: 'Intelligent' biomaterials and tissue engineering constructs capable of mimicking the structure and functionalities of tissues at macromolecular level will be developed and evaluated for use in osteoarthritic and traumatised joint cartilage, periodontic defects, skin burns and chronic ulcers in collaboration with the Blond McIndoe Research Centre, local NHS Trusts and European SMEs.

Chronic diseases: Beta-cell biomarkers specific to immune-mediated beta-cell destruction will be investigated. Factors currently limiting the long-term clinical success of islet transplantation, (for example, cell losses during islet isolation) and implantation will be studied. Drugs known to alter glutamatergic function will be studied (using brain imaging) to determine how these interact with nicotine, potentially leading to therapies for depression and serious psychiatric disorders.

Growth, development and ageing: New electrochemical diagnostic tools for clinical monitoring in a range of applications will be developed and the discovery that cell shape abnormality in early OA tissue is associated with increasing IL-1β will be actively pursued. Work on cellular senescence will continue, with a particular focus on the development of novel natural-product-derived anti-ageing compounds and the development of inducible senescence systems.

Implementation measures and metrics: Our research strategy has both resource and structural implications. Our strategic alignment of QR resource allocation to research priorities has been in operation for almost 20 years (see past RAEs) and has been used to provide contingent resource (for example, studentships and sabbaticals) to enhance the competitiveness of external funding applications, as well as to support pre-competitive research, facilitate networking and raise the visibility of key research outputs. Structural alterations to our staff base are already being managed to facilitate delivery of these goals (see *Staff structure: sustainability*).

In addition, the institution has also committed £700k in infrastructure and equipment funding (and nine PhD studentships) to the development of three cross-disciplinary research clusters (each with defined objectives, defined and measureable metrics for success, a robust management structure and a limited time-frame), which will come on-stream during the next assessment period. The clusters are: (i) *Nanostructured smart materials* (meshing with the EPSRC healthcare technologies research priority). This involves researchers in our *Healthcare technologies* and *Applied clinical* themes in the development of nanomaterials; (ii) *Musculoskeletal disease*

pathology and diagnosis (linked to the Arthritis UK and RCUK priorities) will allow researchers from our *Growth, development and ageing* theme and local clinicians to establish a systems biology approach to musculoskeletal disorders based on a core biobank; and (iii) *Regenerative medicine* (currently a priority with RCUK and Horizon 2020) will involve patients, industry, the Blonde McIndoe Research Centre (qv) and researchers from our *Chronic diseases, Healthcare technologies* and *Applied clinical* themes. This cluster will pursue the development of patient-centred, minimally invasive biomaterial and tissue engineering solutions.

In addition, our *Wellcome Trust Centre for Global Health Research* (awarded 2013, one of only five such in the UK) will support our research in non-communicable tropical diseases and support research partnerships between our researchers and their peers based in low- and middle-income countries.

c. People, including:

I. Staffing strategy and staff development

Our staffing strategy supports our research strategy and is predicated on the following basis:

- We appoint only research active staff (qualified to doctoral level or with equivalent professional experience) with the demonstrable potential to conduct internationally excellent research (generally evidenced either through pre-existing high-quality outputs, through a record of successful grant applications or both)
- We target candidates whose research interests fall only within our core research strengths
- We facilitate linkages between disciplines and grow new research areas through senior appointments and targeted developmental investment (eg the appointment of METCALFE).

Staff support and development – newly appointed staff: Our schools are the home of subject specialities and provide a reservoir of peer-support supplemented with 1:1 support from senior researchers and research administrators. Both start-up funds (typically £3k) and small grants (up to £5k) are available to support research development. The pressures on staff to develop their research base is recognised institutionally and, accordingly, early career academics have their initial teaching and administrative loads reduced by up to 30% over the first two years.

Staff support and development – established staff: All staff are supported to develop their research careers through sabbaticals, personal research strategy reviews, conference support, pump-priming funds and studentships. For example, six staff have benefitted from competitive university sabbaticals (>£85k). Three staff have been awarded innovation and research challenge grants (total of £72k) to stimulate new areas of research (for example, JONES whose research on the role of the human gut microbiota in colorectal cancer led to a successful project funded by the MRC).

Within the units returned in this submission, additional QR funding is deployed to support our staff. Applications for support are peer-reviewed for quality and strategic 'fit' and routinely include: fully funded PhD studentships, conference attendance (up to £1,500 per person per annum) and the costs of open access publications. In addition, the costs of individual licence applications by staff (for example, Class II GMO filings circa £1,000 each) are met out of QR and a policy of repatriation of up to 25% of indirect costs to schools has been in operation for more than a decade for individual investigators to use to support their research and career development.

Our existing sabbatical scheme (including up to six-week leave periods to pursue research at other institutions, as appropriate) is presently being enhanced at institutional level to provide staff with the entitlement to apply for a sabbatical every seven years. The university empowers senior staff through a dedicated Academic Leadership Programme delivered with the Ranmore Consulting Group which covers finance, change management and leadership. Our research leadership capacity has been enhanced through the participation of three of the submitted senior staff on this programme.

Staff structure – sustainability: In the period 2001-2008 more than 16 new appointments were made, including ten ECRs. Of these, three form part of our current submission (MABLEY, ROGERS, and JONES) and others have been returned in different UoAs (for example, WHITBY returned in B7). Thus our staff base is sustainable in both scale and age profile but the number of ECRs in this UoA submission is lower than in RAE2008 (for example, BACHTARZI who brings expertise in premature ageing diseases and advanced therapeutic vector design; SANDEMAN, a

former PDRA at UoB who is now a principal investigator (PI) in her own right and OKORIE). We anticipate at least five retirements during the next few years and plan to refresh our staff base with a mix of senior and EC academics who will help us deliver our research priorities.

Concordat implementation and support for equalities and diversity: Following extensive consultation across the institution, the university developed a Research Concordat Action Plan, overseen by the University Research Strategy Committee (RSC) and monitored by the PVC Research. The Action Plan has been recognised by the European Commission through the award of an *EC European Human Resources Excellence in Research Award*. One broad set of indicators for the impact of our Action Plan is provided by the 2013 Careers in Research Online Survey (CROS; 46% return rate from UoB compared to 26% nationally) that shows:

- 91% of respondents are integrated into the research community (78% nationally)
- 96% of respondents are given the opportunity to present work at conferences (81% nationally)
- 57% of respondents are treated equally compared with other staff in relation to promotion and progression (37% nationally)
- 64% of respondents engage with policymakers and end users (30% nationally).

In 2012, the university appointed an ECR Ambassador to co-ordinate and promote a support network for ECRs across the university and a dedicated web presence to bring them together in an inter-professional setting. Locally, our equality measures include the explicit integration of post doctoral and academic ECRs on school research committees and formal mentoring schemes. All ECRs participate in the university's staff development review that identifies opportunities for researcher development. In 2010, the university initiated an annual, day-long conference, The Future's Bright*,* aimed specifically at promoting the professional, personal and career development of ECRs. This provides workshops on topics such as proposal writing, impact delivery, leadership skills and career development. UoB holds an Athena SWAN Bronze award and has demonstrable success in supporting our female researchers (for example, by ensuring equal career trajectory during maternity), staff with family commitments (through flexible family friendly working) and those with special circumstances.

These measures have allowed us to combine opportunity for international researcher mobility and contractual stability. Over the past ten years, 60% of our postdoctoral research fellows have gained tenure and four members of the Professoriate are either former UoB PDRAs or PhDs. The 40% of postdoctoral staff who leave UoB have developed careers in other academic institutions (for example, University of Southampton, University of Plymouth, York St John University, University College London, Robarts Research Institute, Canada) the industrial or healthcare sectors (for example, GSK, Mars-Waltham, NHS trusts) or professional education. We hold a total of seven Marie Curie Industry-Academia Partnerships and Pathways (IAPP) awards which both provide PDRAs with career development and knowledge sharing with European SMEs and expands the research training, equipment expertise and mentorship opportunities available to them.

c. II. Research students

The university has taken significant steps to enhance the experience of our research students as our contribution to developing the next generation of researchers. All PGRs are now based within the BDC that was established in 2011 under the leadership of a new Dean who is responsible for postgraduate research. Our QAA report in March 2013 noted '*since its [BDC] establishment the trajectory of almost all success indicators has been upward*'. A Director of Postgraduate Studies oversees the application-to-graduation process for all PhD students in the Science and Engineering Doctoral Centre, which is currently home to 158 PGR students**.**

The BDC coordinates PGR student training and development across the university and provides practical support and quality assurance for students and supervisors (including skills and career development). All supervisors complete mandatory training prior to taking students and must attend refresher programmes to maintain their status. PGR students and supervisors within UoA A3 are represented on Doctoral College Committees, and supervisor forums are held three times each year to facilitate communication and staff input. All new doctoral students receive needs-analysis training to establish their skills profile that is then mapped against the Vitae Researcher Development Framework. Formal training is provided through the University Researcher

Development Framework (URDF) within the BDC and all new PGRs are required to demonstrate the learning from core units on research methods, communication, engagement with partners, ethics and IP and undertake training in specialist and transferable skills. Further developmental opportunities arise through participation in the BDC's annual science and engineering conference, which is student-led and organised (65 attendees in 2013). In addition to overseeing the URDF, the BDC fosters a vibrant research culture that includes seminars, workshops and travel grants of up to £1,200 per student to attend conferences.

Our studentship programmes are tightly linked to core end-user groups. Doctoral students who join us with nursing, midwifery and allied health backgrounds normally return to their NHS organisations where their research contributes to evidence-based practice in the local community. Five EPSRC/BBSRC CASE studentships in partnership with Biocompatibles UK Ltd (REF3b [1]) and GlaxoSmithKline have been awarded or completed, leading to technological advances to support the development of novel chemoembolisation therapies for the treatment of hepatic cancer (Biocompatibles UK Ltd). Newly qualified doctoral students wishing to work in partnership with the NHS benefit greatly from the presence of the NHS Research Design Service (South East region, one of only ten RDS nationally).

Our students who have graduated since 2008 have entered a variety of positions globally in academia (for example, Lecturer in Pharmacy, University of Reading; Senior Lecturer, University of Brighton; PDRAs at Fox Chase Cancer Centre USA; University of Florida, USA; Weissman Institute, Israel; Queen Mary's, University College London; University of Geneva; NCSR Deokritos Greece); the NHS (for example, Deputy Chief Pharmacist, Surrey and Sussex NHS Trust; Head of Clinical Governance, East Sussex Healthcare NHS); the charity sector (Battelle Memorial, Baltimore, USA); government bodies (for example, Ministry of Health, Oman); and industry (eg, New Zealand Genomics, Biocompatibles UK Ltd) whilst five have been appointed to research posts at the University of Brighton and the Blond McIndoe Research Centre.

d. Income, infrastructure and facilities

Income: Over the census period our income was £524k per FTE (£14.4m), with income from RCUK increasing six fold and that from bodies specifically funding health research doubling over the period. We have drawn sponsorship from more than 30 funders, including the Research Councils (MRC, EPSRC, BBSRC), Technology Strategy Board, the European Union, the NHS (NIHR, RfPB, i4i etc), industry, charities (Research Into Ageing, Wellcome Trust, Leverhulme Trust, Healthcare Infection Society), private philanthropy and others (for example, Royal Society, PhysioFirst). The diversity of funding sources reflects international collaborative links generated by research within the submission (eg, EU and Wellcome Trust), and close engagement with industrial partners and research end users (eg, NIHR and TSB projects). Fifteen staff, including ECRs, act as leaders on major inter-disciplinary projects, including industrial-academic projects, and funding is evenly distributed across the submitted staff.

Infrastructure and facilities: Over the last five years the university has enhanced significantly the infrastructure that underpins our health-related research. The most visible elements of this are a new biomedical sciences building (the 'Huxley' Building; cost £24m), new clinical simulation environments to support research into student nursing and midwifery decision-making (£400k) and inward investment into our human movement laboratory housed within our clinical research centre. At the time of writing, additional funds as part of an overall £27m refurbishment (2013–15) are being deployed to provide additional research space within the Cockcroft Building.

Reflecting our multidisciplinary research environment, all of our themes can draw on the resources available within our new Huxley Building (3,000m^2 of laboratory space). Huxley houses specialist facilities, including a newly commissioned and expanded Imaging and Analysis Unit, containing FEGSTEM, SEM, AFM (£100k, donated by Biocompatibles) and Confocal Microscopy (funded by an additional £500k University investment), a Clinical Imaging Sciences Centre, a dedicated bioresource centre, HTA licensed tissue and cell culture laboratories, a molecular biology laboratory, histology, a Category 3 Microbiology Suite, radiochemistry facilities and small-scale medical device fabrication facilities. To complement our existing pharmaceutics, chromatographic and spectroscopic facilities, a further £320k has been invested in enhanced analytical instrumentation (400MHz NMR, high-resolution MS and LCMS) and nanoparticle size analysis (donated by GSK). In addition, Huxley houses Europe's only colony of ageing *Lymnea*

stagnalis (used by researchers in our *Growth, development and ageing* themes) and members of our *Applied clinical* theme can draw upon a dedicated Human Movement Laboratory containing circa £800k of human movement and postural analysis equipment, including: strain-gauge force plates, video-based motion analysis systems, an electromagnetic motion tracking and inertial motion tracking system, surface EMG systems, Biodex Dynamometers and unweighing systems and ultrasound scanning system with multiple image grabber, F-Scan Insole system, electrogoniometers, GAITRITE, a somedic vibrameter and an algometer. Cortex MetaMax 3X metabolic systems and spirometry are also available. *Applied clinical* and *Healthcare technologies* research studies are undertaken at either the Leaf Hospital (the university's own dedicated clinical treatment centre) or at the facilities of the Blond McIndoe Research Centre located at the Queen Victoria Hospital (see below). Both the current and former Directors of Research at the Blond McIndoe (JAMES and METCALFE) hold academic appointments at UoB.

The research facilities are supported by seven FTE technicians and eight postdoctoral experimental research fellows. Other university staff (e.g. Business Development Managers (BDMs), European Projects Manager, KTP Office) support research projects and strategy.

Collaborative research infrastructure: We benefit from a range of shared research infrastructure, of which the most important components are: (i) the Blond-McIndoe Research Centre (including cell culture facilities that are GMP accredited and licensed for cell transplantation into patients). This provides a unique capacity to conduct translational research based on a longstanding and exceptionally close working relationship between local clinicians and our scientists. The most readily auditable demonstration of the efficacy of these links is JAMES' work on limbal stem cell culture and transplantation (cited as one of only three key studies for the NICE Interventional Procedures Advisory Committee prior to issuing guidance on using cultivated stem cells to treat limbal stem cell deficiency); (ii) the Allied Health Professions Research Network based at UOB from 2005 – 2012 with a research officer in post supporting 22 HEI-based research hubs; (iii) the National Council for Osteopathic Research based at UoB (2003–2012) which has been a shared resource for a range of stakeholders, for example, the General Osteopathic Council, the British Osteopathic Association and a range of OEIs; (iv) NIHR RDS SE is a collaboration of three universities – Brighton, Kent and Surrey – and is part of the NIHR programmes. Twenty-four researchers from the three universities (eight based at UoB) offer collaboratively the service to NHS and academic researchers, often brokering relationships between the NHS and university academics and sometimes between HEIs. It has partnership arrangements with the BSMS, the NIHR-funded Clinical Investigation Unit (Royal Sussex County Hospital – Brighton and Sussex University Hospitals NHS Trust), the Surrey Clinical Research Centre at the University of Surrey (an MHRA Phase I accredited clinical unit) and is linked in to other NIHR infrastructure organisations such as PCRN and CLRN.

Policy and Practice in relation to research governance: The UoB maintains a Code of Good Practice in Research Guidance and a Guide to Good Practice in Research Ethics and Governance which are reviewed regularly by the University Ethics and Governance Committee, and approved by the university Academic Board. The university has a three-tier ethics and governance review system in place and all NHS-related research is reviewed by an NHS Research Ethics Committee following internal review. Our code of practice for the storage of human tissue was strongly praised on inspection (2013) by the Human Tissue Authority.

e. Collaboration and contribution to the discipline or research base

From 2008 to 2013, our submitted staff published jointly with more than 500 researchers from more than 175 different institutions and companies in 27 countries. Since 2008 we have been involved in more than 24 European consortia linking 20 countries (including extra-European partners such as China and Israel) and have received BBSRC and British Council funding to network UK researchers with Japan, the USA and Spain. Our wider influence upon the research base can be demonstrated by:

Our role in the formation of both national and international strategic priorities: we have identified and changed future research directions through our leadership input to research councils and funding bodies (for example, FARAGHER, member of the BBSRC BBUH Strategy Panel and NiA's study section; LLOYD, member of the EPSRC Healthcare Panel, member of the

BBSRC Committee C; METCALFE, Advisory Panel Member for Technology Strategy Board); the NHS (for example, MOORE, NIHR, chair of clinical academic awards panels and Chair of RfPB; SCHOLES, member of RfPB South East Coast Regional Funding Advisory Committee); the third sector (for example, BONE, Advisory Council and Professional Advisory Council, Diabetes UK; FARAGHER, AgeUK Research Advisory Council member; DAVEY, Executive Director, International Podoconiosis Initiative; industry (JAMES, member of the Industrial Advisory Group of the National Physical Laboratories; and SANTIN, (Scientific Advisory Board member of the Orthopaedic Research UK Foundation).

Our recognised pre-eminence within our disciplines as editorial boards members and invited speakers: all submitted staff are invited to deliver keynote lectures and participate regularly in peer-review (for both funders and journals). Editorial board positions are held on 30 journals, including highly ranked multidisciplinary science journals (for example, *PLoS One*) and those for more specialist research (for example, *Age and Ageing, Manual Therapy Journal*, *Materials Science: Materials in Medicine, Journal of Applied Microbiology and Nursing in Critical Care*), including the top journals in their subject fields (for example, *Aging Cell*).

Our individual reputations as researchers based upon prestigious medals, awards and leadership positions within learned societies: for example, RUSSELL is a Fellow of the Royal Society and holds the Association for Research in Otolaryngology Award of Merit (one of only four UK scientists to do so since its establishment in 1977); OTTER holds the Arthritis Research UK Silver medal (2010); and PATEL holds the GlaxoSmithKline Emerging Scientist Award (2013) for the practical application of knowledge within the pharmaceutical sciences. FARAGHER holds the Glenn Foundation Award for services to biomedical gerontology (the first-ever UK recipient), is Chairman of the British Society for Research on Ageing, President of the International Association of Biomedical Gerontology and is a Director of the American Aging Association. SANTIN is a Council Officer of the European Society for Biomaterials and holds both its Research Excellence Award and the Romanian Society for Biomaterials Award. JONES was awarded the W.H. Pierce Prize for 'significant contribution to microbiology' (2011) and serves on the Executive Committee of the Society of Applied Microbiology. JACKSON is Treasurer of the European Behavioural Pharmacology Society and OKORIE holds the American Heart Association Resuscitation Science Symposium Young Investigator Award (2009). MOORE holds an Honorary Doctorate of Science in association with the British School of Osteopathy for her contribution to research capacity and capability building, and RAJKUMAR was awarded a shield for services to the cardiovascular gerontology by the British Geriatrics Society.

Evidence of our ability to promote collaboration with external bodies: this has already been provided; for example, we lead the NHS RDS (South East) and five members of our submission hold active NHS research passports. With regard to industrial collaboration, SMEs from eight different countries work with us on European projects alone. Further details of our strategy and achievements in this area can be found in our REF3a.

Our organisation and participation in international conferences: all our submitted staff attend and present at international meetings and regularly chair sessions (for example, RAJKUMAR at the British Geriatric Society and JAMES at the European Society for Artificial Organs). FARAGHER has organised special sessions to promote Anglo-American collaboration at the American Aging Association every year since 2005 (underpinning a joint NiA-BBSRC £4m funding initiative linking researchers in the two states) and organised *The Science of Ageing: Global Progress,* the largest conference on the biology of ageing in the world (in Brighton in 2011). SANDEMAN organised *Medical Devices and Carbon Materials: Current Issues in Health and the Environment* (90 delegates from 15 different countries). PATEL organised *Monitoring Molecules in Neuroscience* (in London in 2012, 180 delegates) and the *Comprehensive Local Research Network – Gastroenterology* (in Brighton in 2012) involving 25 health professionals from different sub-disciplines and biomedical scientists. MOORE chaired the Scientific and Organising Committee of the World Congress of Physical Therapists (2011), attended by 5,000 delegates, and is organising the prestigious International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT) 2016 conference in Glasgow.