Institution: University of Bristol

Unit of Assessment: UoA3

a. Overview

The School of Oral & Dental Sciences (UoA3) leads multi-disciplinary research in laboratory, clinical and population sciences. The research in these areas is based around three research groups: Infection & Immunology, Applied Clinical & Materials Sciences and Lifecourse Epidemiology & Population Oral Health. The research groups and laboratories are located alongside clinicians facilitating close working relationships between clinical and non-clinical researchers, and supporting a successful programme of training for clinical academics. The research in UoA3 reflects and links to excellence across the University with each of our three research areas mapping onto university themes in *Infection & Immunology*, *Nanoscience & Quantum Information* and *Population Health*. The School collaborates with the two other Schools within the Faculty of Medicine & Dentistry, and with other Schools across the University. For example, the newly-funded NIHR Biomedical Research Unit, at the University of Bristol and the University Hospitals Bristol NHS Foundation Trust, in Nutrition, Diet and Lifestyle (Bristol Nutrition BRU) is based in our School and several academic and core staff work across UoAs 1-4.

Highlights over the REF period include:

- Grant income awarded of £15.5M (£10.7M spend), equivalent to £950K awarded per FTE.
- Postgraduate training programmes graduated 38 doctoral students, with a further 31 students (including three Academic Clinical Fellows) in current training.
- Award of NIHR Bristol Nutrition BRU (£4.5M), as detailed above, and an Athena SWAN Silver Award (2013) for quality of research environment and career support practices.
- Appointment of 9 new academic staff, with 5 existing academic staff promoted (2 to Professor).

b. Research strategy

Current strategy - Our overall aim is to investigate the causes, prevention and treatment of important oral and general health problems and to apply this knowledge to improve the health of populations and people with disease. Improved treatment and prevention of dental decay, tooth erosion, hypersensitivity pain, periodontal diseases and autoimmune disorders are the focus of our bench-to-clinic research. At the same time, our population and applied research focuses on Cleft Lip and Palate (CLP), Head & Neck Cancer and the development of interventions that improve the health of people with conditions related to poor nutrition. Thus we carry out a wide range of research from investigations at the molecular level (including microbiology, immunology, bioengineering, genetics and epigenetics), to qualitative studies with small groups of people, larger cohort studies and randomized control trials. We support individual scholarship within collaborative multi-disciplinary networks that extend across and beyond the University. Over the review period we have met our strategic objectives.

- **Support for scholarship and collaborative research -** We have supported individual scholarship by developing school wide policies for staff review and development, staff promotion and progression, and mentorship of staff. The quality of our research environment and our commitment to careers of women in science was recognized by the award of an Athena SWAN Silver Award in April 2013. In addition to our policy of UoA-external academic mentorship we have several academic and core staff appointments that work across UoAs1-4, and we run regular multi-disciplinary workshops and meetings to support collaborative research.
- **Focus and alignment with University Themes -** We have successively reconfigured our UoA research into programmes that focus on important areas of enquiry where we have demonstrable research excellence in the School and in the University. All three of our research groups are linked to University Research Themes. This strategic alignment has ensured our research is in areas where there are good long term prospects for excellent science that will be judged competitive by research funders, and that will be relevant to policy makers and society.
- **Development of population science and applied research -** Seven years ago the School set up a population research group - the Lifecourse Epidemiology & Population Oral Health group. The aim was to create a multi-disciplinary research group that could carry out population,

experimental and applied research, and in so doing strengthen our ability to accomplish research resulting in benefits to people with disease. We have made several strategic new staff appointments to the UoA to support this group: Waylen (recently promoted to Senior Lecturer), and lecturers Ke, St. Pourcain and Wills. The £4.5M award (2012) of the NIHR University of Bristol and the University Hospitals Bristol NHS Foundation Trust in Nutrition, Diet and Lifestyle (**Bristol Nutrition BRU**) recognizes the international reputation of the Director (Ness) in nutrition research. The Bristol Nutrition BRU aims to translate knowledge gained from our work on causal associations in nutrition, drawn from population and clinical studies, to develop interventions that improve the health of people with conditions related to poor nutrition. The Unit provides support for systematic reviews, and feasibility and pilot studies, and has enhanced our capacity to promote world-leading integrated programmes of patient-focused research. The Bristol Nutrition BRU provides rapid access for experimental medicine in clinical groups, a comprehensive and imaginative training platform (Atkinson), multi-disciplinary expertise in study design (Ke, Leary, Waylen, Wills), support and expertise with regulatory processes including ethics and R&D, and partnerships to scale up pilot work into large scale clinical trials (with the Bristol Randomized Trials Collaboration and the Bristol Clinical Trials Evaluation Unit).

- The group houses a **surgical research team** (5 research nurses and 3 trial co-ordinators) that recruit into commercial and portfolio studies. The team has just completed recruitment of 400 people to an NIHR Research for Patient Benefit (RfPB) funded trial of post-operative sham feeding (lead Atkinson) and is supporting the peri-operative nutrition theme in the Bristol Nutrition BRU (lead Atkinson, Thomas).
- The group runs a clinical cohort study - **Head & Neck 5000**, funded by a NIHR programme grant led by Ness. The cohort is still recruiting but with nearly 3000 people recruited it is already the largest head and neck cancer clinical cohort in the world. The cohort will become an important bio-resource (DNA and tissue bank) for head and neck cancer research (Ness, Thomas, Waylen). We have two NIHR-funded Clinical Research Training Fellows (Cole-Hawkins, Main) working on linked projects.
- We have a long-standing track record of research in children with **Cleft Lip and Palate (CLP).** We supported a Clinical Standards Advisory Group (Sandy) that reported in 1998. Our research informed the centralization and reconfiguration of services for children with CLP. This has resulted in improvements in the care and outcomes for children in the UK and across the world. We have continued to support the ongoing process of centralization in the UK (and internationally) and obtained funding through an NIHR programme grant (Ness) to carry out a national evaluation of this process that we have just completed (Ness, Sandy). Furthermore we are currently developing an online resource (NIHR RfPB funding) for families affected by CLP (Waylen) that will also provide a resource for future research and training of health care professionals. In recognition of our research track record in this area the group is one of the two sites selected to host the **Cleft Collective**. This is funded by the Healing Foundation who provided £5M with matched funding from the Universities of Bristol and Manchester. The Bristol team are setting up the largest DNA backed longitudinal study of children with cleft lip and palate in the world (led by Sandy and St. Pourcain). The team in Bristol will work closely with the Manchester Cleft trials unit.

- **Expand our research in oral infection -** The Oral Microbiology group was successfully awarded a $2.1M renewal of a programme grant from the National Institutes of Health, Bethesda, USA for studies on preventing biofilm formation by the fungus *Candida albicans* (led by Jenkinson). The Group also hosted two Wellcome Trust funded Clinical Research Training Fellowships (Petersen and Haworth) on studies linking oral microbial infection to cardiovascular conditions. We supported this existing and successful group with the appointment of a new Lecturer (Nobbs). An example of the importance of the work of this group is the discovery of a new mechanism by which blood platelets can be activated by a protein molecule present on the surface of some oral bacteria (Jenkinson). This has been widely publicized in the media as providing further evidence for a link between poor oral hygiene and infective cardiovascular disease. The research, in collaboration with thrombosis experts at the Royal College of Surgeons in Ireland, has provided unique opportunities for testing of new pharmaceutical products to prevent infective cardiovascular disease e.g. thrombosis, infective endocarditis. The work has been reported on national TV and Radio 4, in daily newspapers, international websites, *SimplyHealth* promotion, and monthly magazines, and in public lectures, all facilitated

by the University of Bristol Press Office. As a result our research has increased awareness of the risks of poor oral hygiene among healthcare providers and the general public. We have also sought to expand this area of research by appointing, at senior level, a cellular immunologist with expertise in inflammation (Middleton). The role of this post was to support integration and interdisciplinary working of research in microbiology, immunology and biomaterials research across the School, and to build collaboration with groups in other Schools working on the University Infection and Immunity theme. This has proven successful with recent awards of four RCUK-CASE studentships (Middleton, Su, Barbour), and a Bio-E pump-priming grant (Middleton, Su) supporting bioengineering pilot projects in the South West and South Wales.

- **Research in novel biomaterials -** We have encouraged work on novel biomaterials with antimicrobial properties. An exciting development arising from this research has been the production of nano-modified titanium surfaces with projections that kill bacteria, but allow bone cells to attach and spread across the surface. Potentially these surfaces could have a major impact in preventing prosthetic implant infections following surgery. The research has been undertaken in collaboration with the University of Glasgow (funded by EPSRC). Recent further developments have been seed corn funded by a University of Bristol Pathway to Impact award, Materials Sandpit award, and an EPSRC Impact Accelerator Award (Su, Nobbs, Middleton). In addition, novel chlorhexidine nanoparticles have been developed (Barbour) that adhere to prosthetic surfaces and provide longer term protection against microbial colonization and potential infection. This work is the subject of a recent patent application (with commercial interest from Kemdent and Data Plastics).
- **Partnership with multinational pharmaceutical companies -** We have continued to work closely with multinational pharmaceutical companies such GSK, Colgate, Oral B and Procter & Gamble. We have developed tooth wear models (West) that are now a key stage in the testing of new products, e.g. desensitizing pastes for alleviating pain. The expertise in Bristol (led by West) has resulted in extensive industrial collaborations. New anti-tooth wear and hypersensitivity products supported by our research are now sold in advanced and emerging markets in over 100 countries, and impact on 40% of the adult dentate population.
- **Training of clinical academics -** We are committed to training the next generation of clinical academics. We have hosted five Academic Clinical Fellows during the review period. Four of these have gained Clinical Research Training Fellowships; two from the Wellcome Trust, and two from NIHR. These are our academic clinicians of the future, trained in scientific methods, hypothesis development, acquisition and analysis of research data, and in presentation of their work to scientific, clinical or lay audiences. In addition we continue to run our professional doctorate programme DDS in Orthodontics. We graduated 38 doctoral students during the REF period, 17 DDS and 21 PhD.

Future plans- Our aims over the next review period are to strengthen our capacity to investigate the causes, prevention and treatment of important oral and general health problems and to apply this knowledge to improve the health of populations and people with disease. To do this we have set out some specific objectives:

- **Enhance support for scholarship and collaborative research -** We will refine our policies and the support we provide staff to ensure they have the time and resources to succeed. We have appointed a SWAN champion (Waylen) to ensure that we maintain and develop the supportive environment we provide for female (and male) staff, and maximize our potential success in application for a Gold Award in the next review period.
- **Consolidate population science and experimental research -** We will further develop our capacity to carry out population science by appointing new staff in the next review period. Recruitment will be completed to our DNA-backed clinical cohorts in children with Cleft Lip and Palate (Sandy, St Pourcain) and Head and Neck Cancer (Ness, Thomas, Waylen). We will establish these as bio-resources making a substantial contribution to the understanding of the causes and treatment of these important public health problems. We will continue to support our ability to carry out early phase feasibility and pilot studies through the Bristol Nutrition BRU (Ness). Stronger collaborative arrangements will be developed with the recently awarded MRC Unit in Integrative Epidemiology (MRC IEU) at the University of Bristol, led by Davey-Smith (£23M awarded June 2013). The aim of this Unit is to apply novel causal methods to key research questions related to causes of bone, cardio-metabolic, reproductive, mental and other

aspects of ill-health, and to ensure that the results from these studies are appropriately translated into clinical/public health practice and industrial partnerships. We already have a series of collaborative projects underway but we will look to expand the range of joint studies to more closely link the work of the MRC IEU and the Bristol Nutrition BRU.

- **Diversify our Infection and Immunology research programme -** We plan to diversify our research in this area by extending collaborative research. We are developing cross-disciplinary studies into microbial biofilm formation by collaborating with an expert protein crystallographer (Race, School of Biochemistry) and biological NMR specialist (Crump, School of Chemistry). The objectives are to generate small molecules, based on protein structure information, that will inhibit microbial adhesion to surfaces and thus prevent biofilm formation. Within the UoA, the development of surfaces with novel nano-topographic features (Su, Barbour) will be investigated for antimicrobial properties (Nobbs) and for stem cell integration (Middleton). These projects will open up new funding opportunities. We will also enhance our research base into infective cardiovascular disease by new collaborations with experts in platelet signalling (Poole, Biochemistry) and inflammation (George, Clinical Sciences). Pilot studies have now generated the data necessary for project grant applications to the British Heart Foundation. As part of succession planning we will make at least one new staff appointment at lecturer or senior lecturer level to ensure research in this area continues to thrive.
- **Exploit our expertise in nanotechnology for healthcare applications -** We have developed expertise in novel biomaterials over the current review period and see the exploitation of this work to benefit people with disease as a priority over the next review period. We will actively seek industrial sponsorship, with which we have proven to be highly successful (West); apply for inter-disciplinary RCUK funding and new CASE awards; and integrate research activities with other groups. Specifically, work will investigate mechanisms and treatment of tooth hypersensitivity; fabricate new surfaces for improving integration of implants (Su); develop novel nano-composite materials and coatings for restorative and orthopaedic devices (Barbour). We already work closely in these areas with the School of Chemistry (Woolfson), and Bristol Centre for Functional Nanomaterials (McMaster). We are working with smaller companies such as the National Physics Laboratory and Kemdent to develop novel antimicrobial compounds to protect surgical prostheses from infections. We have recently generated antimicrobial peptides (Su) and nanoparticles (Barbour) as lead compounds through RCUK supported industrial partnerships. We have secured funding for future development of novel antimicrobial surfaces (£330K EPSRC grant funding to Su and Nobbs). Our aim is to take these developments through to first-in-man studies and ultimately into large scale randomized controlled trials.
- **Support collaborative applied health research -** In 2012 Bristol Health Partners (BHP) was launched. This is a formal partnership between the four NHS Trusts in Bristol, Bristol City Council, and the city's two universities (University of Bristol and University of the West of England). BHP is a collaborative organization whose mission is to improve health and health service provision by integrating, promoting and developing Bristol's strengths in health services, research, translation, innovation and education. BHP offers a co-ordinated and dynamic approach that will be used to transform the understanding, prevention and treatment of key health problems in Bristol. This culminated in the recent prestigious award of £9M to CLAHRC West (NIHR Collaborations for Leadership in Applied Health Research and Care), hosted by the University Hospitals Bristol NHS Foundation Trust and led by Donovan (School of Social & Community Medicine). The CLAHRC will provide scientific and methodological support for innovative projects focusing on improving health and healthcare for local people. BHP supports the formation of Health Integration Teams (HITs) to take forward collaborative initiatives in specific areas. These are cross-organization interdisciplinary groups set up to bring together research, innovation, education, patient care, and prevention strengths, to tackle major health priorities. HITs provide a direct co-ordinated and collaborative mechanism for research to have impact in patient care and for the clinical needs of people with disease to change the research agenda. We plan to work closely with both BHP and CLAHRC West to support collaborative applied research. We are already partners on one HIT - *Bristol Inequalities in Early Years Health and Wellbeing*. This HIT will seek to address the issue that 7.5% of Bristol children have a chronic or potentially disabling condition that impacts on their daily lives. The HIT will identify local needs, evaluate oral/dental health inequalities, monitor and respond to upcoming health concerns and develop improved models of care for children and their families. The HIT will

provide a means of anticipating, addressing and preventing increases in health inequalities via targeted actions through pregnancy and early years. A key outcome will be a reduction in admissions for tooth extraction under general anaesthesia and uptake of preventive health initiatives.

- **Extend multi-disciplinary health research -** The Elizabeth Blackwell Institute for Health Research (EBIHR) at the University of Bristol was launched in August 2013. The aim of the Institute is to build a dynamic community of researchers from health and non-health related disciplines to find innovative solutions for some of the most pressing health challenges of the 21st century. It will provide a focused and sustainable collaborative environment for health-related research, encouraging disciplines such as engineering, chemistry, mathematics and social sciences to collaborate with population and medical sciences to improve health. The EBIHR encourages new ways of working, especially at the interfaces between established and emerging disciplines, and will foster collaborative approaches between scientists, industry, clinical practitioners and patients. The Institute offers pump priming for new ideas through the Catalyst Fund and Early Career Fellowship funds to support junior researchers preparing Fellowship applications to MRC, Wellcome Trust, or NIHR. An Early Career Fellowship was recently awarded to Hinton (Research Associate, Bristol Nutrition BRU). We are already working with members of the EBIHR on a major project funded by the Engineering and Physical Sciences Research Council (EPSRC) entitled Sensor Platform for HEalthcare in a Residential Environment (SPHERE). This £12M award is led by Craddock in the Faculty of Engineering at the University of Bristol. SPHERE is a collaboration between 50 academics across the Universities of Bristol, Southampton and Reading in partnership with Bristol City Council, IBM, Toshiba and Knowle West Media Centre (KWMC). We will work closely with the EBIHR to maximize our opportunities for multi-disciplinary health research.

c. People, including:

i. Staffing strategy and staff development

- **Staff appointments -** We have appointed a number of new non-clinical scientists in the review period to strengthen our research areas. These new appointments include: Waylen (Lecturer in Psychology, 2008); Ke (Lecturer in Health Economics, 2009); Nobbs (Lecturer in Oral Microbiology, 2009); Middleton (Reader in Immunology, 2010), an expert in inflammation biology; St. Pourcain (Lecturer in Genetic Epidemiology, 2012); and Wills (Lecturer in Statistics, 2013). The appointments have led to high-impact publications and exciting new funding initiatives. We have also appointed clinical academics to key posts to support our research areas. These include: Thomas (Professor in Oral and Maxillo-Facial Surgery, 2009); Pring (Consultant Senior Lecturer in Oral Pathology, 2010); and West (Professor in Restorative Dentistry, 2010).
- **Staff promotions -** We are committed to supporting and promoting staff. We therefore promoted five staff during the review period. These were: Ireland to Reader (2009) and then Professor (2012); Leary to Senior Lecturer (2011); Waylen to Senior Lecturer (2013); Atkinson to Senior Research Fellow (2013); and Su to Reader (2009) and then Professor (2013).
- **Staff development -** We have an annual process of Staff Review and Development (SRD) where we assess staff progress, agree strategic objectives and identify training needs. In addition, all clinical academic staff are offered NHS reviews at the same time where their job plans are reviewed to ensure the workload and priorities of clinical academics are co-ordinated and agreed.
- **Supporting women in science -** Over the review period we have appointed, supported and promoted female academics in the School. We have been awarded the prestigious **Athena SWAN Silver** (2013) in recognition of our support for women in science.
- **Nurturing early career researchers -** All early career researchers are based within one of our research areas and are supported by relevant senior research staff. Funds are made available by the School to support preliminary and pilot work. They are also encouraged to apply for seed corn money available from the EBIHR and the Faculty Dean.
- **Training opportunities -** We identify training needs as part of the annual SRD and we have developed formal training policies for groups such as the Nutrition BRU. We encourage staff to attend relevant University courses offered by the University Staff Development team and by other Schools including the short course programme in the School of Social and Community

Medicine. We run external research seminars with invited speakers (hosted by the School of Oral & Dental Sciences and Bristol Nutrition BRU), internal "present and discuss" seminars, reading groups and journal clubs. We encourage our staff to attend relevant training courses (identified through SRD) and to present their work at conferences.

- **Promoting collaborative research -** We support a number of research networks and are active contributors to the relevant University Theme meetings. We provide funds to support sabbaticals and to attend and run research workshops. The School has several academic staff that work across UoAs1-4, and promotes UoA-external academic mentorship. We use these approaches to encourage multi-disciplinary working and to establish and maintain research networks.

ii. Research students

- **Support for research students -** We have a comprehensive policy for research students that supports their learning, identifies their training needs, and reviews their progress. Each student has at least two supervisors (and in some cases three). We also have a School Graduate Studies Tutor who provides additional pastoral support. The training opportunities described above are open to students as well as staff.
- **The Bristol Doctoral College -** The University of Bristol has recently created this College to provide facilitates and co-ordination for doctoral training and research development across the University. We will work closely with the College to ensure we offer our postgraduate researchers comprehensive skills training and career guidance.
- **Postgraduate students -** We have an active and thriving postgraduate student community, with 69 students (30 of them clinically qualified) studying for higher degrees in the review period. In total, 38 students have graduated with doctoral qualifications and of these, 21 were PhD degrees (95% PhD full-time 4 yr completion rate). Sixteen PhDs were externally funded (Research Councils UK, Wellcome Trust, foreign government and industry) with five CASE studentships. In keeping with our own commitment to supporting and developing our staff, five of the postgraduate students were staff members registered for higher degrees. We currently have 31 students in postgraduate training (9 DDS and 22 PhD). Three PhD students have Academic Clinical Research Training Fellowships (1 Wellcome Trust, 2 NIHR), 5 have Research Councils UK CASE awards, 4 are USA NIH-funded, 2 are NIHR-funded and 8 are in cross-UoA supervision (as part of Research Councils UK quota or Doctoral Training Centre funding).
- **Training clinical academics -** The School was awarded five Academic Clinical Fellows (ACFs) in the review period. Two have obtained competitive Clinical Research Training Fellowships from the Wellcome Trust (Petersen, Haworth) and two from NIHR (Cole-Hawkins, Main). In addition we continue to run our professional doctorate programme in Orthodontics and graduated 17 DDS Orthodontic students over the review period in this research-based higher degree. The DDS programme recruits a new intake every three years. This explains some of the observed year on year fluctuations in postgraduate student numbers.
- **Career prospects for our students -** Many of our students continue with research careers or move to jobs in industry. Of the 38 postgraduates completed in the review period, first port-of-call employments were as follows: 10 postdoctoral research, 7 academic clinical appointments, 2 industry, 2 teaching, and 17 into clinical practice (some with further clinical training).

d. Income, infrastructure and facilities

Income

- **Overall income -** We were awarded £15.5M in grants from NIHR, Research Councils UK, commercial sponsors, charities and overseas government agencies in the review period (£10.7M spend). This represents income of £950K per full time equivalent staff in our return. We have a balanced portfolio of funding across our areas of work and sources of funding.
- **Funding for population science and applied research -** Our strategic investment in population and applied research has successfully resulted in the award of £9.3M over the review period. These include an NIHR programme grant (Ness, £1.8M); two NIHR RfPB grants (Atkinson, Waylen, £0.5M); the creation of the Healing Foundation Cleft Collective (Sandy, Ness, £2.5M) and the Bristol Nutrition BRU (Ness £4.5M). Some of these funds are administered through the NHS and distributed through other Schools.

- **Funding for laboratory science -** Our continued excellence in laboratory science has attracted funding from the US National Institutes of Health - the $2.1M programme renewal from NIH for oral biofilms research (Jenkinson), and from UK research councils - £1.4M from RCUK (Su, Nobbs, Barbour)
- **Industry partnership -** Our continued partnership with multi-national pharmaceutical companies has resulted in awards of £2.7M from industry (West, Su, Barbour).
- **Research fellowships -** We secured Clinical Research Training Fellowships totalling £0.7M for four Academic Clinical Fellows (2 from Wellcome Trust, and 2 from NIHR).
- **PhD studentships -** We have been awarded 11 RCUK PhD studentships (6 EPSRC, 3 MRC, and 2 BBSRC) including 6 industrially partnered CASE awards (to Barbour, Middleton, Su). There are currently 8 PhD students who are co-supervised as part of doctoral training centre programmes (e.g. Bristol Centre for Functional Nanomaterials) or competitive MRC/EPSRC quotas.
- **Support for population science across the University -** Some of the research funds included in years 1-3 of the review period represent continuing commitments to running research council and charity awards in the School of Social & Community Medicine, led by Ness in his role as a member of the Avon Longitudinal Study of Parents and Children Executive.

Infrastructure and facilities

- **School facilities -** The School has extensively refurbished laboratories (>1200 m^2) and specialized clinical research facilities (100 m^2), a bench top scanning electron microscope, fluorescence imaging, microindenter (from GSK) and Cyclone 3D imager (donated by Renishaw). Sufficient office space for all research groups is available within the School, and newly refitted office space for the Bristol Nutrition BRU is in the adjacent Trust Education and Research Building. The research groups and laboratories are located alongside clinicians facilitating close working relationships. A new outreach centre in the South Bristol Community Hospital will provide additional opportunities for clinical and applied research.
- **University shared research facilities -** The University has a number of excellent shared facilities that we are able to use through our research networks and that have led to joint publications. These include: the Wolfson Bioimaging Facility, School of Biochemistry (housing five confocal microscopes and the latest TIFR microscope for live imaging); Flow Cytometry Facility (3 laser 4-way cell sorting); Proteomics Facility, School of Biochemistry (Orbitrap Velo MS); NMR, SEM and Scanning Probe Microscopy (School of Chemistry); the Clinical Research and Imaging Centre. A new £54M Life Sciences Building now houses all proteomics and genomics facilities and will offer resources to support ongoing collaborative research.
- **University support for scholarship -** The University provides a range of services to support research excellence. These include: library support (10 branches) and eResources; AddLiBS library service for distance working; a comprehensive range of IT services; high performance computing; data management support; links to business and industry through the Bristol Enterprise Network and Science City Bristol; membership of World Universities Network (WUN); dedicated RED office for project management, commercialization, contracts, and governance.

e. Collaboration or contribution to the discipline or research base

- *Collaboration*

Each of our research programmes has achieved extensive national and international collaborations, and has been proactive in facilitating research discussion and communication in the wider context of the research base. Internationally, we have vigorous links with other institutions and leading centres of excellence, all supported by joint research funding and publications: China (Donghua University, Central South University, University of Shanghai for Science); Singapore National University; USA (Harvard University, University of Louisville, State University of New York at Buffalo, Cornell University, University of South Carolina); and Europe (University of Groningen, University of Dublin, University of Bern, Umea University, University of Leuven, University of Munich, University G.D'Annunzio). We align with three University Research Themes, *Infection & Immunity*, *Nanoscience & Quantum Information*, and *Population Health.* We collaborate with an extremely wide range of researchers within these themes and centres and have generated joint publications, obtained co-investigator grant awards and supervise joint PhD students. Researchers within our UoA3 work with and jointly publish with researchers in the University of Bristol

submissions UoA1-5, UoA7-9 and UoA12-13. Overall, UoA3 research encompasses a spectrum of disciplines with which we productively engage to produce internationally acclaimed research of highest quality.

- *Membership of Research Councils or similar national or international funding bodies*

EPSRC Peer Review College (2003-, Su); Healing Foundation Research Council (2004-11, Sandy); Research Grants Council of Hong Kong (2005-, Su); NIHR RfPB Funding Committee SW (2006-10, Ireland); Wellcome Trust Immunology and Infectious Disease Funding Committee (2006-9, Jenkinson); Research Council of Norway Biology and Biomedicine (FRIBIO) Funding Committee (2008-11, Jenkinson); BBSRC Panel of Experts (2010-, Jenkinson).

- *Chairing of national or international research or health strategy panels*

Chair Steering Committee UWE Centre for Appearance Research (2003-, Sandy); Principal Expert on Orthodontic Materials British Standards Institute (2008-, Ireland); Chair Survivorship Sub-Group, Head & Neck Cancer Clinical Study Group (2010-, Thomas); Chair Consultant Orthodontics Group Committee, British Orthodontic Society (BOS) (2010-3, Ireland); Research Lead Craniofacial Society of GB and Ireland (2011-2, Sandy); Director BOS Foundation (2013-, Ireland)

- *Membership of national or international research or health strategy panels*

Animal Health Trust Scientific Advisory Committee (2005-9, Jenkinson); Specialist Advisory Board Orthodontics, RCSE (2007-, Ireland); National Cancer Research Institute, Head and Neck Clinical Study Group (2010-, Thomas); Trustees' Board Healing Foundation (2011-, Sandy).

- *Leading positions in professional subject associations or learned societies*

SW Regional Representative British Society of Periodontology (2003-, West); Publications Officer and Council, Society for General Microbiology (2009-12, Jenkinson); Secretary British Microcirculation Society (2009-12, Middleton); BOS Board of Trustees (2010-3, Ireland); President IADR Microbiology & Immunology Group (2011-3, Jenkinson); British Society for Oral and Dental Research Council (2010-3, Jenkinson); Secretary British Society of Periodontology (2012-3, West).

- *Editorial/associate editorial positions and editorial board membership*

Seven staff have been editorial board members on 18 international scientific journals, with Jenkinson currently Editor-in-Chief of *Molecular Oral Microbiology* (Wiley-Blackwell).

- *National or International conference major organizing roles*

Four members of academic staff have been on organizing committees or symposium chairs for 14 major international conferences over the REF period. The School hosted the 60th British Society for Oral and Dental Research meeting in September 2013.

- *NHS or Industry collaborations*

NHS: UCL Institute of Child Health (Dezateux), £1.3M Wellcome Trust, (2008-11, Ness); Cochrane Oral Health Group (Worthington) and Marsden (Nutting), £1.8M NIHR, (2009-14, Ness); Harvard University Boston Children's Hospital (Field), $2.7M NIH, (2009-14, Ness); EAGLE Consortium MRC (2011-, St. Pourcain); Cleft Collective UK (2011-, Sandy); James Lind Alliance (2011-, Thomas); MCRN Cleft & Craniofacial Anomalies Clinical Studies Group (2012-, Sandy); Integrative Epidemiology MRC Unit Bristol (Davey-Smith), £6M MRC/Wellcome Trust, (2011-4, Ness). *Industry:* GSK Consumer Healthcare (1994-, West); Co-founder and Consultant Applied Functional Materials Ltd (2004-, Su); Expert advisor for Oral B (1994-, West), GABA (2007-, West), Unilever (2003-, West), Colgate (2007-, West), Philips (2012-, West), and SwissDent (2012-, West); ESCARCEL European non-carious dental lesions hypersensitivity programme (2010-, West); Consultant GSK (2007-, Middleton); GSK collaborative projects and studentships (2008-, Barbour); Procter & Gamble (2007-, West); GWR studentships with the Orthodontic Company (2008-11, Ireland); Novartis Research Vienna (2009-12, Middleton); National Physics Laboratory (2009-, Su); Corin GWR/EPSRC PhD studentship (2010-, Su); Kemdent PhD studentship (2010-, Barbour).

- *Invited keynote or plenary lectures at major international conferences*

Plenary, *1st World Universities Network (WUN) Symposium on Oral Health Science*, Nanjing, China 2009 (Su); Keynote, *7th International Orthodontic Congress*, Sydney, Australia 2010 (Sandy); Plenary, *WSEAS International Conference on Medical Pharmacology*, Cambridge 2010 (Middleton); Keynote, *2nd WUN meeting on Oral Health Science*, Leeds 2011 (Su); Keynote, *Japanese Cleft Lip and Palate Association*, Tokyo, Japan 2012 (Sandy); Keynote, *8th International Conference Quality of Life in Head and Neck Cancer*, Liverpool 2012 (Waylen); Plenary, *American Association for Dental Research*, Tampa, Florida 2012 (Jenkinson); Keynote, *Dutch Orthodontic Congress*, Ameland, Holland 2013 (Sandy).