Institution: University College London

Unit of Assessment: 03A Allied Health Professions, Dentistry and Nursing (Dentistry)

a. Overview

The UCL submission of UoA3 (Dentistry) comprises the activities and vision of UCL Eastman Dental Institute (EDI; of the Faculty of Medical Sciences) and Dental Public Health (DPH; of the Faculty of Population Health Sciences) within the School of Life and Medical Sciences (SLMS). Staff returned here engage in basic, clinical and translational research and collaborate extensively with researchers across UCL and in universities across the globe. Research is organised into four groups: (1) Microbial Disease (2) Biomaterials and Tissue Engineering (3) Clinical Research and (4) Dental Public Health. Research is strengthened by our continued strategic alliance with the NHS, particularly University College London Hospitals NHS Foundation Trust (UCLHT), funding from the UCL/UCLHT NIHR Comprehensive Biomedical Research Centre and our inclusion within University College London Partners (UCLP) Academic Health Science system.

The unit's vitality, commitment to, and organisation of research are reflected in our significant achievement in the REF census period:

- Key outcomes of relevance to the research base
- External income of over £9 million with income of over £280k per FTE
- Funding allied to national and international oral health priorities
- Over 700 original research publications, with UCL staff contributing over 12% of all UK publications in Dentistry/Oral Surgery and Medicine (RAND, 2013) and staff representing the highest cited in their fields (**Knowles** (Web of Knowledge: 2nd most cited in Biomaterials in the UK); Implantology, **Donos** (author of top cited paper of Clinical Oral Implants Research, 2011))
- Strong outputs in translational research: over 22 Randomised Controlled Trials (RCTs) published
- 160+% increase in enrolment of Postgraduate Research (PGR) students with over 100% increase in PGR:Staff ratio
- Increased commercialisation of research via 5 patents filed and 1 licenced
- Staff awarded competitive externally funded senior lectureships (**D'Aiuto**) and lectureships (**Petersen**, **Rodriguez**)
- Sustained success in research-based staff promotions
- Productive interdisciplinary collaborations with UK and international academia, industry and the NHS.

b. Research strategy

Our strategy is to undertake high-quality research that advances knowledge of the causes, treatment and prevention of orofacial and related disease and to translate such findings into improved clinical care and public policy. The delivery of this strategy is supported by a commitment to multi- and inter-disciplinary translational research in a stimulating environment with productive collaboration with other universities, industry, patients and the public that encourages and rewards research innovation and supports colleagues at each stage of their career.

Each research group has contributed to this strategy by increasing income and PGR numbers, delivered key outcomes, developed or expanded strong collaborations and has in place plans that will enhance the research impact of the UoA.

Microbial Disease (Head – **Nair**) is focused upon the aetiology, pathogenesis and control of diseases caused by oral and healthcare associated infections. Research is integrated into three themes: ***i***. antibacterial strategies and resistance, ***ii***. biofilms and ecology and ***iii***. cellular microbiology, each of which has achieved outcomes of relevance to our strategy and national and international priority areas.

Research highlights include the demonstration of a new class of antibiotic resistance genes in the oral cavity with the first description of an ABC transporter conferring tetracycline resistance in oral streptococci (**Allan**, **Mullany** and **Roberts**, *Antimicrobial Agents and Chemotherapy*), the identification of several novel mobile genetic elements in *Clostridium difficile*, the demonstration of their importance for adaptation to the host environment (*PLoS ONE*) and the demonstration that the co-localization of antiseptic and antibiotic resistance genes on mobile elements in oral bacteria has important clinical ramifications, as the selection of one will lead to the selection of the other (*J*

Antimicrob Chemother). The sustained work on antibacterial strategies has led to the development of novel nanoparticles for use in magnetic hyperthermia or as photosensitisers for lethal photosensitisation of bacteria (**Nair**, **Wilson**, *J Mater Chem*) as well as the development of novel light-activated antimicrobial polymers (**Wilson,** *Biomaterials*). Some of the patents generated by this work were exclusively licensed for the disinfection and sterilization of tissues, wounds and lesions in the oral cavity in an agreement between our technology transfer office UCL Business PLC (UCLB) and Periowave Dental Technologies in 2011. Translation to the clinical setting has been facilitated by the recent completion of 3 trials investigating light-activated antimicrobial polymers for disinfecting inert surfaces in hospitals funded by the Department of Health and UCLB; the efficacy of antimicrobial polymers as coatings for urinary catheters is presently being trialled via the MRC Development Pathway Funding scheme (DPFS).

Work on biofilms and ecology, in collaboration with the Biomaterials and Tissue Engineering group, has included the development of remineralizing, antibacterial dental materials (**Spratt** and **Young,** *Acta Biomater*). Our artificial mouth models of oral health and disease, and a clinical trial in collaboration with our Clinical Research group, has demonstrated that some foods have beneficial effects on oral health. This work has resulted in a patent filing (Products with health benefits, Patent ADP number: 8836884001 (**Spratt** and **Wilson**)). Our biofilm work has also identified a novel compound for disrupting biofilm formation by *Campylobacter jejuni* and the filing of a patent **(Allan** UK filing no: 1311272.7). In *Cellular Microbiology* **Henderson** and **Nair** demonstrated that a genetic competence protein possessed by all members of Pasteurellacea combines the functions of a fibronectin adhesin and DNA binding and thus contributes to the virulence of the oral pathogen *Aggregatibacter actinomycetemcomitans* (*PLoS ONE* and *Infect Immun*). We have demonstrated that horizontal gene transfer can convert non-toxigenic bacteria into toxin producers, which has implications for the treatment of bacterial diseases (**Allan**, **Mullany** and **Roberts**, *Nat Commun*). Cellular microbiology has been strengthened by the appointment of **Smith** who has reported macrophage dysfunction to bacteria in Crohn's Disease **(Smith**, *J Exp Med* and *PLoS ONE*).

Biomaterials and Tissue Engineering (Head - **Knowles**) is focused upon the development of novel methods of repair and regeneration of tissues. The research of this group is organised in three themes: ***i*** development of new materials for hard and soft tissue generation, ***ii*** enhancing understanding of the interaction of tissue with these new materials and ***iii*** developing probe methodologies that can be applied to both the materials and the cellular components to gain insight into their interaction.

With regard to the development of new materials, **Knowles** determined the effects of site substitution of Mg upon the structure of hydroxyapatite with implications for bioactivity and processability (*Biomaterials*) and developed an elastomeric patch for the delivery of stem cells to the heart (*Biomaterials*). **Young**, in collaboration the Clinical Research group developed curable, reactive calcium phosphate cements to induce remineralisation of surrounding tissues and act as a marginal sealant (*Acta Biomaterialia*). The understanding of the interactions of tissues with new materials has been significantly advanced by the work of **Brett** who has detailed the role of key bone matrix components that underlie titanium-induced accelerated osteogenic differentiation of mesenchymal stromal cells (*Bone* 2012). **Hunt**, **Knowles** and **Shah** have demonstrated that scaffolds provide a means of successfully regenerating muscle (e.g. for craniofacial repair) (*J Tissue Regen Med* 2012). The group's work on probe methodologies has been focused upon collagen. **Bozec** has demonstrated the application of coherent X-ray diffraction for the determination of the structure of collagen, of relevance to mechanical studies of connective tissue of the mouth and other structures (*Proc Nat Acad Sci* USA). The group has driven commercialisation through the licensing of patents e.g: ***i.*** Formulations and composites with reactive fillers. (e.g. patent numbers WO 2008/037991; **Young**); ***ii.*** filed a patent establishing a new method for delivery of Cisplatin from Sol-gel glasses (WO2010/029307, **Knowles**) and ***iii.*** filed a patent for the use of a novel compound to increase re-mineralising, antibacterial and self–repair properties of reactive CaP composites for tooth and bone repair (UK filing no: 1313898.7,**Young**).

Clinical Research (Head - **Donos**) is focused upon the identification of phenotype, genotype, systemic impact and outcomes of therapy of oral disease. The group has three main themes: ***i***.

wound healing; ***ii***. inflammation and infection; ***iii***. outcome-based oral health.

The group's research on wound healing, particularly that associated with titanium surfaces of osseointegrated implants, has described for the first time the gene expression profiling of bone healing/osseointegration (**Donos**, *Clin Oral Implants Res*). The group have published extensively on bone regeneration in response to implant placement **(Mardas, Donos,** *Clin Oral Implants Res*). Using novel techniques, including for the first time proteomics, the wound healing mediators of gingival crevicular fluid have been determined **(Donos**, *J Proteome Res*). The group has isolated stem cells of the adult human periodontal ligament (**Donos**, *Tissue Eng Part A*) and demonstrated novel osteogenic and angiogenic peptides for regeneration of periodontal ligament and bone tissue (**Donos** and **Knowles**, *Acta Biomater* and *Tissue Eng Part A*) - which also resulted in filing of a patent (W0201077086). The work on Inflammation and Infection has delivered outputs of relevance to common oral and systemic disease such as detailing of the association between periodontitis and oxidative stress (**D'Aiuto**, *J Dent Res* and *Free Radic Biol Med*). **Fedele** and **Porter** determined the long-term outcomes of bisphosphonate-related osteonecrosis of the jaw (*Am J Med*), and with **D'Aiuto** and **Donos** demonstrated that oral mucosal inflammation is independently associated with inflammatory markers of cardiovascular disease (*Am Heart J*). **Petrie** demonstrated the elimination of visceral amyloid by antibodies to serum amyloid P component (*Nature*). Outcome based oral health has systematically reviewed the association of periodontitis to metabolic syndrome **(Nibali** and **Needleman,** *J Clin Endocrinol Metab*), obesity (**D'Aiuto**, *Obes Rev*) and the association of genetic polymorphisms and failures of dental implants (**Donos** and **Mardas**, *Clin Oral Implants*). **Needleman** has defined the potential benefits of full mouth disinfection in the treatment of periodontitis (*Cochrane Database Syst Rev*) and evaluated for the first time the impact of hospitalization on oral health (*J Clin Periodontol*). The benefits of fluoride for enamel erosion have been determined *in-vitro* by **Rodriguez** (*J Dent*) while **Gulabivala** and **Ng** have defined the factors that influence outcomes of non-surgical root canal therapy (*Int Endod J*). **Cunningham** has determined the motivations of patients requiring orthognathic treatment (*Am J Orthod Dentofacial Orthop*).

Dental Public Health (Head - **Watt**) is principally focused upon: (i) determinants of oral health inequalities and (ii) public health interventions to promote population oral health. This group has produced research outputs of relevance to oral health in the UK and internationally**. Tsakos** and **Watt** have detailed the interaction of social gradient upon oral health of adults (*Am J Public Health*) and defined the effect of cognitive ability within socio-economic inequalities of oral health (*J Dent Res*). The impact of social support upon infant feeding practices was established (**Tsakos**, *J Epidemiol Community Health*) and that poor oral hygiene is associated with increased risk of cardiovascular disease (**Watt**, BMJ). **Watt, Tsakos** and **D'Aiuto** defined the relationship between periodontal inflammation and hypertension (*J Hypertens*). The quality and importance of this work are reflected in their shaping of local NHS oral health care delivery policies in London and their inclusion in national epidemiological surveys, including the 2009 Department of Health Adult Dental Health Survey in England, health policies in England (e.g. *Choosing Better Oral Health* & *Delivering Better Oral Health*) and European oral health policy agendas (*The State of Oral Health in Europe*).

Research engagement. The achievements of the staff of this UoA are reflective of a culture that encourages the engagement of staff and students at all levels, through: ***i.*** regular open discussions to promote research outcomes, proposals, potential interdisciplinary collaborations, aspects of training (see below) and engagement with funders ***ii.*** periodic away days/research retreats ***iii.*** weekly lectures by invited national and international researchers ***iv.*** regular PGR led "upgrade" seminars (at the point of transfer from MPhil to PhD) ***v.*** wide electronic promotion of research funding calls and ***vi.*** active maintenance and utilisation of the UCL Institutional Research Information System (IRIS).

Response to RAE 2008. In line with our intentions of RAE 2008 we have achieved:

- Nurturing of early career staff to success: securement of grants **(Fedele);** high impact publications **(Bozec);** promotion within UCL/UCLHT (**Adams** and **Bozec**) and 10 Post-doctoral scientists to academic posts nationally and internationally (including**: Ahmed** –

Nottingham**; Hope** – Liverpool; **Valappil** – Liverpool; **Wall** – UCL Biochemical Engineering; **Ciric** – UCL Civil Environmental and Geomatic Engineering**; Harle** – UCL Medical Physics and Bioengineering**; Warburton** – Anglia Ruskin**; Aboul Neel** – King Said, Saudi Arabia; **Chrzanowski** – Sydney, Australia).

- Utilisation of platform technologies by themes to strengthen research in particular: Genomics (Microbial Disease: antimicrobial resistance and the oral metagenome (Allan, Mullany, **Roberts**) novel antimicrobials (**Nair**)**;** Clinical Research – Bone healing (**Donos, D'Aiuto**), Periodontitis (**D'Aiuto**, **Donos**, **Nair**, **Spratt**) and BRONJ (**Fedele**, **Porter**)), Proteomics (Clinical Research - Periodontitis (**Donos**), Sjogren's syndrome (**Fedele**, **Porter**)) nanotechnology: (Biomaterials and Tissue Engineering: (Collagen disease (**Bozec**)); Social and Life Course Epidemiology (Dental Public Health (**Tsakos**, **Watt**)).
- Securement of NIHR funding (**Fedele**, **Porter**, **Tsakos** and **Watt**)
- Productive strategic collaborations within the UoA and within and out with UCL as detailed below.

Research plans. Our plans for each group for the forthcoming 5 years include:
Microbial Disease:

- Translation of our light-activated antimicrobial strategies for use in patient treatment and self-decontaminating surfaces and equipment in hospitals and the workplace. Funding has been secured from the Department of Health, UCL Business and the MRC DPFS to support this activity
- Development of novel phage-directed treatments for healthcare associated infections**.** This will build upon the work of **Allan**, **Mullany** and **Roberts**.
- Research on oral ecology will be expanded by metagenomic studies to define the relationship between the human microbiota and oral and systemic health. £1.1 million has been secured by UCL researchers (including **Spratt**) from the Wellcome Trust for a pilot investigation.
- Studies of innate immunity in relation to oral and systemic health will build upon **Smith**'s work on monocyte function.

Biomaterials and Tissue Engineering:

- Translation of reactive composites for orthopaedic and dental applications towards clinical trials, in collaboration with industrial partners. Exploitation will progress via current EPSRC funding (e.g. **Young**) and future applications to the EPSRC for healthcare engineering grants.
- Establishment of Centre for Doctoral Training in Biomedical Engineering. A second round application is currently under consideration by the EPSRC.
- Further development of international links with Dankook University and via the Korea Research Foundation BK21+ programme in conjunction with Duke University (funding of $2 million per annum for 7 years).
- The strategic appointment of a Senior Lecturer in neural regeneration (**Phillips**) will allow expansion of research allied to muscle regeneration and enable stronger links with the Aspire charity funded lectureships based at the Royal National Orthopaedic Hospital and UCL.

Clinical Research:

- We intend to evaluate the healing outcomes and efficiencies of novel surgical and non-invasive procedures for the treatment of oral diseases and their impact upon quality of life and health economics. Funding will be sought from the NIHR and EME.
- We will explore the influence of oral inflammation upon renal disease, obesity and COPD. Funding will be sought from the NIHR and relevant charities.
- Development and application of Patient Reported Outcome Measures for oral disease. Primary data is presently being collected in collaboration with the London School of Hygiene and Tropical Medicine (LSHTM) for later submission for funding from the NIHR.

Dental Public Health

- Interventional studies of the roles of primary dental health care providers in the promotion

of healthy lifestyle will be undertaken. Funding has been secured from Public Health England and via the NIHR Research for Patient Benefit Programme.
- International comparisons on determinants and patterns of oral health inequalities are planned with funding secured from the ESRC and NIDCR.
- Innovative community-based complex interventions for prevention will be developed and tested in general dental practice networks and public health organisations. Funding is being sought from the NIHR Public Health Research and Applied Research Programmes.

Our research capabilities and capacity will be further enhanced by the intended appointment of Chairs in Biomaterials and Tissue Engineering and Microbial Disease. Additionally, we are planning a relocation to the central UCL Bloomsbury campus in 2017-18, allowing us to build upon our existing use of platform technologies housed centrally at UCL and further unite the research activities of EDI and DPH. Our Microbial Disease group will form the nexus of an expanded Infection Division within the planned UCL/London School of Hygiene and Tropical Medicine Bloomsbury Research Institute (BRI) while the Biomaterials group will be leading the development of Biomaterials within UCL's Institute for Biomedical Engineering (IBME). Our plans for the expansion of translational research include the development of a new Clinical Research Facility (CRF) close to a new UCLHT Head and Neck Centre. Separately, an Oral Health Education Centre will be established to expand delivery of research-led education and increase the potential for knowledge transfer.

c. People

Staffing strategy and staff development. We continue to attract and retain outstanding staff to further advance research and teaching. Recent strategic appointments have included early career staff to expand translational research (**Nibali** - collaborates with the UCL Cardiometabolic Domain) and **Leeson** who will drive randomised controlled trials, in association with the new Institute of Clinical Trials and Methodology in the Faculty of Population Health Sciences. Established researchers have been strategically appointed to expand Cellular Microbiology within Microbial Disease (**Smith**) and to enhance collaborations between Clinical Research and Microbial Disease (**Vianna**) and Biomaterials and Tissue Engineering (**Petridis**). We have successfully recruited early career researchers within the NIHR ACL scheme to enhance Microbial Disease (**Petersen**) and Clinical Research (**Rodriguez**).

We are committed to ensuring our recruitment, retention, engagement and promotion of staff is based on the principle of merit, free from discrimination and bias. Our recruitment adheres strongly to a belief in equality and the benefits of diversity. The latter is reflected by our securement of quality staff from throughout the EU and beyond (e.g. Brazil and Australia). Our commitment to working towards gender equality is reflected in the appointment of 5 women between 2008-11 (representing an 83% increase in female representation of research-active staff). Women accounted for 60% of all promotions of REF-returned staff (for example: to Senior Lecturer (**Ng**)**,** Reader (**Young**) and Chair (**Cunningham**)), and hold key leadership roles (e.g. **Parekh** as Director of Education**, McDonald** as Head of Prosthodontics, **Leeson** as Deputy Departmental Graduate Tutor). We will be applying to Athena Swan for Silver status in November 2013, this being led by **Young** and **Porter**.

There is cultural commitment to and recognition of the benefits of a diverse workforce, and we have actively sought to ensure the recruitment and retention of outstanding staff. Funding is provided to ensure reasonable adjustments are made in the workplaces of staff with disabilities/specific needs (e.g. modification of office facilities and/or acquisition of software) with additional support provided in partnership with the Access to Work programme. Funding is available to cover responsibilities when staff wish to take extended leave (e.g. maternity and carers' leave). Staff are encouraged to achieve a work-life balance, with opportunities for flexible working (including off-site) being promoted and all key organisational meetings occurring in core working hours to support this.

All staff have protected research time that is reviewed regularly by our adherence to staff training and participation in robust appraisal mechanisms that also assure the personal development needs of staff are advanced and the health and probity of staff reviewed. Assurance of the appropriate

balance of clinical:academic activities, their adherence to relevant mandatory training and CPD is achieved for all clinical researchers via our compliance with the joint appraisal policies of UCL and its NHS partner organisations. We adhere to the probationary policies of UCL for all new appointments with assurance of the development and support of early career staff being achieved by the UCL Staff Review and Development scheme, support of local leads and mentorship by seniors within UCL. We ensure that all early-career clinician researchers undertaking clinical training have job plan adjustments to meet their research and training needs and we adhere to the policies and procedures of the "Gold Guide" NHS policies and procedures via assessments with an educational trainer and appraisals within the Annual Review of Competence Progression (ARCP) scheme. The appointment and promotion of staff to honorary clinical positions always adheres to the policies of the allied NHS Trust (e.g. Advisory Appointments Committees).

Success of our staff strategy is evidenced by ***i.*** academic promotion of staff at all stages of the academic career ladder including previous early (**Fedele**, **Mardas** and **Roberts** to Senior Lecturer) and mid-career staff (**Bozec, Brett** and **Ng** to Senior Lecturer; **Spratt** and **Young** to Reader; **Cunningham** to Chair) ***ii.*** Promotion of clinicians to Consultant-grade status (**D'Aiuto, Fedele, Parekh** and **Shah**) ***iii.*** securement of grant funding by early career (**Petersen**), and previous early-career staff (**D'Aiuto, Fedele, Roberts, Shah**) ***iv.*** Securing of an NIHR Senior Lectureship (**D'Aiuto**) ***v.*** promotion of previous staff to senior positions within industry (**Pratten** to GSK**; Buxton** to Novartis) and research lead universities (**Lewis** to Dean of School of Sport, Exercise and Health Sciences, Loughborough**; Tredwin** to Director of School of Dentistry and **Moles** to Chair, Peninsula Dental School).

Research students. We have a flourishing, vibrant and diverse community of PGR students as evidenced by our 160% increase in PGR numbers from RAE 2008, the completion of 54 doctorates in 2008-13, a sustained improvement in PhD completion times (70%+ completed in 4 years over the period 2008-13), evening of the male to female ratio of PGRs from 63% in 2008 to 56% in 2012/13 PGRs, increased PGR:staff ratio from 0.95 to 2.03 for current students, increased diversity of specialities of supervisors, the introduction of a Doctorate of Dentistry in Paediatric Dentistry (D.Dent) and strong engagement with the welfare and development of PGRs.

We promote opportunities for postgraduate research via regular advertisement in journals, on our and UCL's website, conference exhibitions and direct contact with potential sponsors. We have reviewed our dialogue with applicants to ensure that they understand the needs and requirements for a PhD, as well as providing them with further guidance towards choosing the appropriate research theme to undertake a PhD or D.Dent. As such, a more didactic list of research projects was created online which led to a quicker and simpler recruitment process. The recruitment process is coordinated by Departmental Graduate Tutors (**Bozec** in EDI, **McMunn** and **Britton** in Public Health) and, as with staff, adheres to the principle of recruitment on the basis of merit. Our global reputation for research and welcoming institutional culture is reflected in the international profile of our research students – as indicated below.

In the period 2008-13 ~40% PGRs have been funded following competition for non-UK government studentships (e.g. Saudi Arabia, Brazil, Libya, Iraq, Pakistan) as well as via individual competitive studentships funded by the BBSRC, EPSRC, MRC, RCUK Doctoral Training Centre and EU FP7. Other funding for our PGRs has come from industry (11%), UCL Scholarships (14%) and student self-funding (22.5%). UCL SLMS together with the UCL/UCLHT Biomedical Centre established the Grand Challenge studentships of which 2 were awarded competitively to prospective PhD students of the UoA. In addition, we secured 7 PGRs via UCL's impact studentship programme in which 50% funding is provided by UCL with the remaining 50% being secured by our staff via collaborations with Industry. Finally, we currently have 3 CASE students sponsored by RCUK and industry.

All PGRs have a supervisory team comprising a primary supervisor and a secondary (or joint) supervisor. The primary supervisor must have completed a period of supervised probation, be expert in the research field and have supervised at least one PhD to upgrade as part of a team. PhD students are registered initially for MPhil and only transfer to PhD following satisfactory

performance via our robust upgrade processes. In the census period the PGR success at upgrade has been 100%. All PGRs attend a SLMS-wide induction training programme, led by staff of this UoA that provides initial training in generic and transferable skills. Monitoring of PGR progress, identification and planning of skills training needs are achieved by quarterly review with UCL-approved supervisors and use of a skills self-assessment tool of the UCL research student log. PGRs also meet every six months with their Departmental Graduate Tutor to review progress and need for additional support. The PGRs are encouraged to attend the wide range of transferable skills courses provided for all research students by UCL's Graduate School; currently there are over 200 different courses across the full range of skill domains defined by the Researcher Development Framework, and over the census period our PGRs have attended 735 events representing 900 days of skills training and professional development. Within the UoA, there are pastoral tutors available to independently provide care/advice to PGRs, and as per staff, funds are available to support students with disabilities or specific learning needs. Active engagement with EDI and wider UCL quality assurance processes are encouraged by student representation on relevant committees (e.g. Staff Student Consultative Committee).

Engagement of the PGRs with the researchers of the UoA is encouraged as detailed under 'Research Engagement' above. The PGRs also participate in monthly journal clubs and separate "coffee clubs" to discuss research in a non-supervisor informal environment with the DGT. The PGRs have access to local funding for participation/attendance at conferences and to contribute to our public engagement.

d. Income, infrastructure and facilities

Income. Since RAE 2008 grant income per FTE has increased 48%. The UoA has secured grants totalling £9.6 million. We have continued to secure funding from the research councils relevant to our research and in line with our strategy of RAE 2008 we have had growth in funding allied to Clinical Research (NIHR funding allied to the RISC, RfPB and i4i schemes, Diabetes UK, BHF) that have attracted ~£186k funding from the London Comprehensive Local Research Network as part of their recognition as portfolio status. All four groups have successfully achieved research income in the period 2008-13. Within Microbial Disease major awards include: EU: FP7 €5.37 million (**Wilson**, **Mullany**, **Roberts**, **Spratt**), MRC: £1.1 million (**Wilson**) and £582k (**Mullany**, **Roberts**), EPSRC: £505k (**Wilson**), BBSRC: £440k (**Wilson**), Wellcome Trust: £458k (**Mullany**, **Allan**, **Henderson**, **Spratt, Wilson**) and the BHF £239k (**Henderson**). Highlights of grant income to Biomaterials and Tissue Engineering include: EPSRC: £993k (**Young**, **Ashley**, **Bozec**), EU FP7 – NanoforArt: £228k (**Bozec**). Awards within Clinical Research have been from the NIHR £249k **Fedele, Porter**), Diabetes UK £125k (**Donos**, **D'Aiuto**) and MRC £142k (**Donos**). Major funding of Dental Public Health awards have been secured from the NIHR totalling £870k (**Watt**), the US National Institutes of Health/NIDCR £185k (**Watt**), the ECRC £63k (**Watt** and **Tsakos**) and the Department of Health £187k (**Watt** and **Tsakos**, Adult and Child Dental Health Surveys).

Funding of UCL/UCLHT Comprehensive BRC has provided funding of £1.99 million to Eastman Dental Hospital to support research nurses and administrators and £186k for a clinical trials coordinator and other salary costs of our Clinical Investigation Centre, all of which has enabled us to complete, and publish, over 22 RCTs. This in addition to £998k secured via collaborative research and studentships with industry including GSK (**Spratt**), Johnson & Johnson (**D'Aiuto**), Procter and Gamble (**Spratt**), Pfizer (**Donos**), Phillips (**Donos**), Philips (**Nair**), Optident UK (**McDonald**) and Institut Straumann AG (**Donos**).

Management processes for grant applications have been strengthened via robust review of all applications by senior researchers of the UoA and/or relevant staff of other UCL departments as well as designated research coordinators within SLMS or other UCL Schools. Applications for randomised control trials are reviewed by the Clinical Trials Unit within the UCL Cancer Institute. Applications to the NIHR are reviewed at different stages by the London East Research Design Service of the NIHR. All research active staff are encouraged to attend training sessions on grant writing provided by funding councils, the Wellcome Trust and UCL SLMS. Additionally, the UoA has arranged on-site training of staff by senior researchers and research coordinators of the UoA and/or UCL. Assurance of appropriate costings of all grant proposals is achieved via the finance officer of UCL EDI and those of the UCL Research office.

Facilities and infrastructure. Facilities within the Microbial Disease laboratories include laboratories for bacterial and genetic modification work that contain class I and class II biological safety cabinets and anaerobic chambers. There are dedicated laboratories for microscopy (light and florescent), molecular biology (sample preparation robot, PCR and QPCR machines), mammalian tissue culture work and for biofilm work (apparatus for fermentation and for numerous biofilm models including artificial mouth setups). Biomaterials and Tissue Engineering has facilities for light, fluorescent, atomic force and Fourier Transform Infrared microscopy, ion chromatography and digital surface photogrammetry. Our Clinical Investigation Centre houses 4 dental clinics dedicated to research and facilities for the preparation and secure storage of samples, all maintained to a standard expected by the HTA. Each research area has a designated manager and a cadre of technicians/support staff. There are robust policies for the training of PGRs and staff that are reviewed by the Health and Safety committee of EDI on a termly basis.

Over the past 5 years UCL has developed a policy of centralising and sharing key facilities allied to platform technologies: genomics, proteomics, imaging, transgenics and computational and systems biomedicine and SLMS has invested £17.8 million in this period in such resources. UoA staff have engaged in this opportunity by utilising the facilities and collaborating with leads in the technologies to achieve joint PhD supervision (genomics: **Donos**, **Fedele**, **Spratt**; proteomics: **D'Aiuto Donos**, **Nibali**), secure grant income (**Fedele, Spratt, Wilson**) and outputs in high impact journals (e.g. **Bozec**, *Nature Nanotechnology*; **Mullany**, *Nature Communications*; **Petrie**, *Nature*).

The imaging facilities within BTE are a key component of the imaging platform technologies and as part of a coordinated facility are central to the research of this UoA and SLMS. We have established a joint Transmission Electron Microscopy (TEM) facility with UCL Institute of Orthopaedics with the TE microscope being located and upgraded at a cost of £28k within EDI. As part of this we have very recently invested £100k in a new high resolution Field Emission Gun Scanning EM with a micro-CT facility to enable three-dimensional imaging at the nanoscale. We have also expanded our Atomic Force Microscopy (AFM) facilities with the acquisition of a second AFM system to allow combined thermal analysis with imaging. We have established a Biobank, with an appropriate governance structure, for oral tissues and blood thus forming the "dental" element of the "Open Biobanks@ucl" cluster.

To enhance information services to staff and PGRs we have invested £100k in hardware for our research seminar rooms/lecture theatres as well as upgrading of PCs of staff and PGRs to provide roaming access to central servers as part of strategy of "sync and share" IT connectivity. Wireless internet connectivity has been extended to provide connections across all sites within all staff and student areas. Library facilities across UCL have been upgraded with strategic investments including the launch of the new home for UCL research output, UCL Discovery, and improvement of access to e-resources necessary for research. At a local level, the UCL Eastman Dental Library has secured access to new specialist resources, such as the EBSCO Dentistry and Oral Sciences source and a senior staff member has been appointed within this library to collaborate on systematic reviews.

Research is actively supported by central UCL facilities; in particular research is supported by the Translational Research Office (TRO) of SLMS to facilitate the securement of funding relevant to research translation into therapies. The TRO, together with UCL Business PLC, secured £32k for **Allan** and **Nair** of Microbial Diseases for studies targeting the serine/threonine protein kinases of Gram-positive bacterial pathogens. The commercial potential of our research is reflected in the secondment of a UCLB manager to EDI one day per week for the past 6 years. Where relevant we also engage with UCL Consultants (UCLC), UCL Enterprise, the European and International Offices and Pro-Provosts, the joint UCL/UCLHT R+D and UCL/UCLHT BRC to optimise the grant applications and knowledge transfer opportunities, coordinate administration in relation to collaborative research and to ensure adherence to research governance.

e. Collaboration or contribution to the discipline or research base

Collaboration: We promote and have productive interdisciplinary collaborations across UCL (e.g. Chemistry, Civil, Environmental and Geomatic Engineering, Institutes of Child Health and Orthopaedics, Infection and Immunity, Cancer, Cardiometabolic, Surgery, London Centre for

Nanotechnology) and the NHS (UCLHT Medical Microbiology, Surgery; Camden and Islington PCT). Additionally we have sustained, productive collaborations outwith UCL: *Microbial Disease*: UK (Animal Health and Veterinary Laboratories Agency; Health Protection Agency; King's College London, St George's, Universities of Nottingham and Glasgow and the Sanger Institute for Genome Research) and international universities (e.g. Academic Centre for Dentistry Amsterdam, University of Berne, University of Genoa, Göteborg University, University of Pavia, Universita di Siena, University of Tel Aviv, University of Verona, University of Zurich, Karolinska Institutet, Ruhr-Universitaet Bochum). *Biomaterials and Tissue Engineering*: UK (Imperial College London, Queen Mary, Nottingham) and international universities (Dankook, Korea and Aveiro, Portugal). *Clinical Research*: UK (Surrey) and international (Aarhus (Denmark), Stuttgart (Germany), Hong Kong (China) and Griffiths (Australia)). *Dental Public Health*: UK (Newcastle, Birmingham, Glasgow and Cardiff) and globally (Brazil, Japan, South Korea, India, Thailand, South Africa, Malaysia, Australia, Sweden, Spain, US, Canada and Finland). Exemplars of interdisciplinary collaborative endeavour include: ***i***. EU FP6 (NUTRIDENT) and 1 FP7 (ANTIRESDEV) funding **(**PI - **Wilson)** and NIDCR **(**Co-I - **Watt)** funding ***ii***. research and PGR training partnerships with the University of Dankook **(Knowles)** ***iii***. research with industry ***iv***. Industrial partnerships allied to EPSRC funding **(Young)** ***v***. Industrial partnership of PGR training ***vi***. Significant numbers of research publications with collaborative authorship.

Contribution. UoA staff contribute significantly to leadership and enabling of the research base, and are recognised, by virtue of ***i. Awards/Honours allied to research***: UK Society for Biomaterials (**Knowles**); Young Investigator Award, Centre for Biofilm Engineering (**Roberts**); IADR Regenerative Medicine Award (**Donos**), EAO Basic Research Award (**Mardas**), Women in Science and Engineering (**Young**); Honorary Doctorate of Medicine (Goteborg: **Porter**); Honorary Chairs (Griffiths and Hong Kong: **Donos**) **ii. *Review Board membership*:** NIHR RfPB (**Watt**); Wellcome Trust Basic Science Committee (**Bozec**); EPSRC (**Knowles**) **iii. *Peer review of funding proposals***: MRC, BBSRC, EPSRC; NIHR; Arthritis Research UK; CRUK; Diabetes UK; Nuffield Council; Wellcome; European Orthodontic Society; Deutsche Forschungsgemeinschaft (DFG) Germany: the US National Science Foundation (NSF), and National Research Foundation of South Korea. **iv. *Leadership of responses to national priorities*:** Chairperson of DoH working party on *Smokefree and Smiling* (**Watt**); Assessor to the review of NIHR BRCs (**Knowles) v. *Research leadership roles within UCL***: Pro-Provost for Europe (**Wilson**); Deputy Director of Institute of Biomedical Engineering (**Knowles**) **vi. *Journal editorship***: J of Biomaterials Applications (**Knowles**); J Tissue Engineering (**Knowles**); Mobile Genetic Elements (**Roberts**) **vii. *Associate Editorship***: Int J of Oral Pathology and Medicine (**Porter**); Int Endodontic J (**Gulabivala**); Deputy Editorship: Community Dental Health (**Watt**); Advances in Fluorine Science (**Knowles**) **viii. *Editorial Board Membership***: J of Dental Research (**D'Aiuto, Knowles, Watt**); Oral Diseases (**Fedele, Porter**); J of Clinical Periodontology (**Brett, Needleman, Nibali**); Seminars in Orthodontics (**Hunt**); Clinical Oral Implant Res (**Donos, Mardas, Needleman**); BMC Microbiology (**Nair**); Frontiers in Microbiology (**Allan, Henderson, Mullany**) Int J Paediatric Dent (**Ashley**); Int J Endodontics (**Spratt**); Int J of Oral and Maxillofacial Surgery (**Henderson**); Int J Oral Pathol Med (**Henderson**); J Med Micro (**Nair**); Mobile Genetic Elements (**Allan, Mullany**); J of Dentistry (**Knowles**); J Periodontology and Implant Sci (**Knowles**); J Biomaterials Applications (**Young**); J of Orthodontics (**Cunningham, Hunt**) **ix. *Elected Leadership of learned societies***: Dental Faculty of RCS England (**Hunt** – Dean-elect) **x. *Leadership of professional societies***: Presidents of British Endodontic (**Gulabivala**) and Orthodontic Societies (**Hunt**), British Association for the study of Community Dentistry (**Watt**), European Associations of Oral Medicine (**Porter**) and Dental Public Health (Vice-Chair: **Tsakos**); Council/Committee membership of the British Orthodontic Society (**Cunningham, Shah**), British Society for Periodontology (**Donos**), British Society for Endodontics (**Ng**), British Society of Paediatric Dentistry (**Ashley**), European Society for Endontology (**Gulabivala**), European Orthodontic Society (**Cunningham**) Oral Microbiology and Immunology Group (**Spratt**), Society of Glass Technology (**Knowles**), International Team for Oral Implantology (**Donos**), European Association for Osseointegration (EAO) (**Donos**) and the European Federation of Periodontology (**Donos**) **xi. Organisation of research-focused international conferences**: European Association of Oral Medicine (**Fedele, Porter**); NanoforArt (**Bozec**); Royal Microscopical Society (**Bozec**) **xii. University external assessor**: Hong Kong Dental School (**Porter**), Keele (**Knowles**), Leeds (**Spratt**).