Institution: Plymouth University

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

a. Overview

The submission for this UoA draws on the research activity of 4 Schools: Health Professions, Nursing and Midwifery (both in the Faculty of Health and Health Sciences), Biomedical Sciences and Dentistry (both in PUPSMD, the Plymouth University Peninsula Schools of Medicine and Dentistry). Research Groups aligned with each of these Schools are coordinated through two overarching Research Centres: the Centre for Health and Social Care Innovation (CHeSCI) and the Centre for Research in Translational Biomedicine (CRTB). These Research Centres provide common facilities and resources for clustering researchers with recognised expertise to achieve critical mass in specific areas and enabling constructive overlap. Research activity is managed by a combination of Centre-based and School-based mechanisms and policies. Coherence between Centre and School agendas is achieved through the Directors of CRTB and CHeSCI also holding posts as Deputy Heads for Research in their Schools. Advisory groups, including representatives from the NHS and industry, inform the strategic research direction of the Centres and allow them to respond to local and national priorities relevant to translational biomedical research and health research. The work of the Centres is aligned with University strategy through the major University Institutes, the Institute of Health and Community (IHC) and the Institute for Translational and Stratified Medicine (ITSMed).

CHeSCI (Director; Prof Ruth Endacott) supports the Health Professions, Nursing and Midwifery, and Dentistry Groups and aims to promote and develop research in areas related to health and social care, to support inter-disciplinary collaborations working in clusters on specific themes, to build research capacity in Health, and to share methodologies, collaborations and research infrastructure. Its work links with work in social policy, social work, and education through IHC. CRTB (Director; Prof. Simon Jackson) supports Biomedical Science, a new and developing research area at Plymouth University (PU) that was introduced in its own right in 2009. The remit of the CRTB is to develop research in cellular and molecular biomedical science and to exploit the translation of this research into diagnostics, therapeutics, and bio-sensing technology in the healthcare setting. The Identification of potential projects for further exploitation by the NHS, industry or university spin-out activity is a key aim of CRTB. Its work links with wider developments in clinical medicine through ITSMed. CHeSCI and CRTB provide the vibrant research environment that facilitates internal and external inter-disciplinary collaboration and supports research training and the exchange of ideas and methodologies in order to bring to bear a critical mass of research expertise that can play a key role in the promotion and dissemination of health and biomedical research at local level.

Research work is conducted on 3 university sites and numerous healthcare/NHS sites. The Drake Circus city campus currently hosts most of the nursing and biomedical research and also includes a new university clinic, the 'Centre for Eyecare Excellence (CEE)' for optometry research. Most of the Allied Health Professions research is conducted at the Peninsula Allied Health Centre (PAHC), co-located with PUPSMD and the main regional acute hospital at Derriford, some 4 miles to the north of the city centre. To develop research collaborations and further embed biomedical research with strategic developments in the PUPSMD, the University has invested £25M in staff recruitment, infrastructure, and extending the Derriford campus. Biomedical science and CRTB will relocate to the medical sciences campus in the next 2-3 years and there are plans for most other health-related research to also re-locate to this Northern Campus site over the next 10 years.

The work of the Research Centres is undertaken through clusters of themed research.

Centre for Health and Social Care Innovation (CHeSCI)

This encompasses three of the research groups returned in this submission. The 'Rehabilitation Research' and 'Visual Sciences' clusters are located within the Allied Health Professions Group, the 'Applied Health Genetics', 'Sustainability, Society, and Health', 'E-Health', and 'Clinical Skills Innovation' clusters are located within the Nursing and Midwifery Group, and the 'Primary Dental Care' cluster is located within the Dentistry Group.

The ***Rehabilitation Research Cluster*** comprises five staff (Marsden, Freeman, Paton, Bunn, Shum) and eight PhD students, bringing together expertise in biomechanics, neurophysiology, and clinical outcome measurement to evaluate the efficacy and mechanisms underlying targeted interventions, whole-care packages and processes of service delivery. Research focuses on acquired and inherited long-term conditions such as Multiple Sclerosis, Chronic Low Back pain and

Hereditary Spastic Paraparesis. Research in this area reflects the priorities of health and social care services and the views of patient support groups obtained through regular focus groups and collaboration with clinical local research networks. Its outputs include 32 peer-reviewed publications, it receives European Union, Government and Charity funding, including an NIHR fellowship for Paton, and knowledge transfer partnerships and grants through the Multiple Sclerosis Society and Trust & Muscular Dystrophy Campaign (£731K total).

The ***Visual Sciences Cluster*** comprises three staff in Optometry (Mroczkowska, Buckhurst P, Buckhurst H, Garcia-Suarez), a new discipline for the university, and three PhD students. Members work on ocular imaging and biomechanics, psychophysics, glaucoma, and instrumentation for the assessment of visual function. Specific areas of interest include understanding the structural correlates of myopia, evaluating the biomechanical and visual outcomes of pseudophakic and phakic correction, and developing improved understanding of the pathogenesis of glaucoma. The research into pseudophakia involves several multicentre studies, and includes both national and international research institutes across Europe and North America. Its outputs include 18 peer-reviewed publications, and it receives funding from Government and charity sources including the College of Optometrists (£32k) and industrial companies such as Bausch and Lomb UK (£410K total).

The ***Applied Health Genetics Cluster*** **(**Skirton, Jackson, Goldsmith, O'Connor and Doris) has a programme of work focused on delivery of effective healthcare services to individuals, families or populations affected by or at risk of a genetic condition. The work can be categorised into two streams: studies directly concerned with the experience and needs of service users and studies designed to explore and support improvement of professional competence in genetic healthcare. A key thread that binds these two aspects of the work is the development and use of new genomic technologies in the health service setting. An example is collaboration with colleagues in the UK and Japan to explore the acceptability and application of new types of non-invasive prenatal testing. FP7-funded studies undertaken in conjunction with multiple European partners are developing standards and guidelines for offering genetic and genomic testing in a range of clinical settings in Europe.

The ***Sustainability, Society and Health Custer*** is a cross-Faculty multi-disciplinary cluster comprising Richardson, Grose, Morris, Nichols, Tighe and Jones. It was established in 2010 to explore issues and seek solutions to the sustainability challenges presented by climate change, fossil fuel, and food security to society and health. These challenges are addressed through research, education, information, and action drawing on diverse experiences and disciplines. Members work closely with the Centre for Sustainable Futures, with which there have been joint Fellowships, and the Institute for Sustainability Solutions Research (ISSR).
Research mainly focuses on reengineering services to support the sustainable use of health and social care resources and the cluster has worked with external organisations to help build sustainable communities, promote outdoor space for sustainability, and explore sustainability, society, and wellbeing. Many of the cluster's initiatives involve health informatics as a sustainable method of healthcare delivery and for supporting teaching and learning so as to embed sustainability into the curriculum and raising sustainability consciousness within the student population.

The ***E-Health Cluster*** (Jones and Boulos) focusses on the impact of e-health and Next-Generation Internet Solutions in health and social care . Its work comprises interdisciplinary projects and proposals at the various stages of evaluation from exploratory work, through pilots, to randomised trials. Research activity includes research into e-learning, tele-healthcare, standardisation and interoperability, knowledge management/Semantic Web, techno-social predictive analytics, e-surveillance services, and Cancer GIS. Examples of recent and current projects include user-led development of a pre-clinic app for young people with diabetes (with the Medical School), development of online support for allergy services in the Peninsula (with Derriford Hospital), and exploration of a shared discussion forum between health professionals and young people who self-harm (with Devon Partnership Trust).

The ***Clinical Skills Innovation Cluster*** comprises 3 key researchers (Endacott, Williamson, Stenhouse), 10 junior collaborators, and 6 internal and 4 external PhD students. Its research work examines factors influencing how change in a patient's condition is assessed and managed. This work spans acute/chronic and age-range continua, with studies undertaken in a range of out-of-hospital, critical-care, and ward settings. Studies in the clinical skills laboratories include identifying

the impact of different modes of skills learning on clinical student's knowledge and self-efficacy.

The ***Primary Dental Care Cluster*** (Moles, Nasser and Kay) focuses its research on ways of enhancing understanding of the mechanisms, processes, and circumstances that affect oral and systemic health and the interactions between both oral and general health. Members are involved in devising, translating, and evaluating interventions using evidence-based and theoretically sound methods to promote health and wellness that are fit for purpose and in appraising and improving the quality and appropriateness of oral health care services as measured both clinically and by user perceived value to reduce health inequalities. The Plymouth Dental School aims to become a leading academic centre fostering excellence in research and education in the field of primary dental care.

Centre for Research in Translational Biomedicine (CRTB)

This encompasses 3 research clusters included in this submission: the 'Infection, Immunity and Inflammation', 'Molecular Cell Biology', and 'Personalised Medicine and Diagnostics' clusters.

The ***Infection, Immunity and Inflammation cluster*** includes seven academic staff (Jackson, Fejer, Lasonder, Upton, Fern, Anichtchik, and Jarvis, the latter returned to UoA1), 16 PGRA, and 3 PDRA's. It has seen a major investment in staff resources and has expertise in cellular and molecular immunology, gene silencing, cell biology, cell signalling, monocyte/macrophage differentiation and activation, regulation of innate immune responses, and mucosal immunomodulation and vaccine development. The primary aim of this group is to understand the cellular and molecular regulation of immune responses for the development of novel diagnostic, therapeutic and vaccine strategies for immune and inflammatory diseases. The recent arrival of Upton and Zaric (Dental School) has strengthened research in innate immunity, especially macrophage activation and TLR signalling. Cramp (Medical School) collaborates on Viral Hepatology. Jackson has identified a novel enzyme regulator of TLR-induced inflammatory responses and a potential target for anti-inflammatory therapy, Fejer has produced a novel macrophage cell line that is utilised to understand innate immune sensing and signalling, and Lasonder has characterised the malarial proteome. Fern and Anichtchik have strengthened research into inflammatory processes and other stressors on neuronal development. Jackson, with Purcell, is supported by Astra Zeneca in developing novel 3D cell culture models and assessing them by proteomics- and transcriptomics-based techniques for biomarker development, infection models, and environmental pharmaceutical screening.

The ***Molecular Cell Biology cluster*** comprises three submitted staff (Affourtit, Billington, Sewell), together with 12 PGRA and 2PDRA and brings together expertise in genomics, cell signalling, calcium imaging, molecular biology, pathology, gene regulation and cell biology to the study of mitochondrial dysfunction and cancer. The primary aim of this group is to understand fundamental biomedical cellular and molecular processes and pathologies of these disease states and to identify potential markers and targets that can be developed into novel diagnostic and therapeutic strategies. Jankowski and Rule in the Medical School collaborate closely in cancer research.

The ***Personalised Medicine and Diagnostics cluster*** comprises 4 academic staff (Avent, Belshaw, Vlahou and Green, the latter returned to UoA1), together with 6PGR, 3 PDRA, and a clinical research fellow (Roberts). Members use molecular genotyping, environmental monitoring, and biomedical instrumentation for the development of novel diagnostic approaches, such as Belshaw's use of endogenous retroviral sequence data for novel cancer diagnostics. This cluster follows an agenda of personalised medicine in relation to the development of next-generation sequencing and encompasses enhanced bioinformatics and more focussed diagnostics. Bioinformatics provision during diagnostics and delivery to the healthcare sector is of critical importance and, in collaboration with medical statistician Wright in the Medical School, a key objective for this research area includes novel solutions for the analysis of post-genomic data sets. Key developments, funded by the NIHR and EC FP7, include Avent's novel methods to deplete maternal DNA, and enrich fetal DNA for non-invasive pre-natal diagnosis (NIPD) and screening. This work includes recent patent filings and forms one of the impact case studies for this submission.

b. Research strategy

The recent reconfigurations referred to above, and the establishment at Plymouth of new academic health disciplines such as biomedical science, dentistry, and optometry, have enriched health-related research and created the need to develop research around more integrated

groupings. The need to develop and embed research in a diverse range of taught programmes was also recognised alongside closer engagement and integration with clinical practice to realise the full impact of research outputs. These aims and the goals outlined below, informed and are endorsed in the University's Research and Innovation Strategy and the University 2020 Strategy for academic development. These have helped to shape our research priorities and organisational structure into an integrated university-wide strategic planning process that coordinates the various constituent research groups and clusters. The key goals in those strategies as they relate to health are:

(a) To develop world-class research in dentistry, nursing, midwifery, biomedical science, and physiotherapy, where there is a pre-existing research track-record.

(b) To support disciplines, such as optometry, that are new to the University but that offer future research potential and also support research themes relating to 'life-course' and the ageing population that are of national and regional significance.

(c) To build research capacity, particularly in research leadership and independent researchers, and align research activity to key health-related themes. To provide facilities and equipment concordant with this increased research capacity.

(d) To develop and nurture embryonic research in focused areas of new academic disciplines such as paramedicine and occupational therapy that offer exceptional research potential but to date have limited research activity.

(e) To capitalise on selected interdisciplinary research opportunities afforded by the wide range of health-related disciplines offered at Plymouth University and encourage researchers to engage with clinical practice wherever possible to optimise research impact.

(f) To encourage the development of critical mass through building a research infrastructure and pursuing collaborative opportunities by organising research through the Institutes and Centres of the University.

(g) To create a focussed, supportive structure that provides a sustainable base for health – related research, opportunities for staff development, and a vibrant, challenging environment for the career development of ECR's to ensure they reach their full potential. Overall the goal is to secure appropriate succession-planning.

(h) To increase success in securing research funding from external sources by creating an environment where shared expertise and experience will enhance the quality of bids.

(i) To provide a rich and rewarding academic experience and high-quality research training for postgraduate research students.

The strategies and plans developed within the Schools and Centres that comprise the UoA to achieve the above goals are summarised below, together with evidence of achievements to date over the current assessment period.

Research Plans, Investment and Disinvestment.

Plans: Having created a sustainable structure for the organisation of research, resources to build research capacity and quality will be mainly focussed on the defined research clusters and their themes to deliver against the goals described, particularly those demonstrating the potential to produce world class research and those aligned to regional, national or international research priorities in healthcare. Although optometry, biomedical science, and dentistry are relatively recent disciplines at Plymouth University, their national and international research profiles suggest strong future potential.

Inter-disciplinary research is facilitated by the "porous-boundary" nature of the research groups and the organisation of research through Centres. Examples of developing collaborations between clusters include that between Rehabilitation and Visual Sciences on falls in the elderly and between Sustainability and e-Health on the contribution of digital technology to sustainable healthcare. CHeSCI and CRTB provide a visible presence for health and biomedical research and its constituent clusters of academics. They have fostered collaborations with other university Centres and Institutes such as the Institute for Sustainable Solutions Research.

The research performances of CHeSCI and CRTB are monitored annually against key performance indicators, such as research income, research outputs, and PhD completions, by the Faculty Research Committees and the University Research and Innovation Committee Centre performance informs investment strategy and academic direction.

***Areas of Investment*:** Key areas for investment have been identified as the strengthening of research leadership, leadership succession, and mentorship through the appointment of research professors of international standing, making full use of other academic vacancies as they arise to appoint quality research-active staff, and providing high-quality research facilities for staff and research students. Where appropriate, these developments are integrated with, or embedded in, clinical practice in support of goals a, c, e, f, g, h above.

Examples of professorial appointments since 2008 and alignment to research clusters include Avent and Jackson in Biomedical Sciences in 2009 and 2010, Moles in Dentistry in 2009, Sewell in Clinical Pharmaceutics in 2009 and Kent in Nursing Leadership in 2012. (See also section c, 'People' below). Chairs in Biomechanics and Podiatry, Dietetics/Nutrition, Oral and Dental Health, and Nursing are under active recruitment in support of all the above strategic goals.
In addition, Faculty and Research Centre funding to support the employment of Research Fellows for 2 or 3 years were awarded to several clusters in all 4 Research Groups on a competitive basis in support of goals a, b, c, e, f above.

Strategic investment in research facilities and accommodation in support of goals c and f since 2008 includes postgraduate research student work rooms (in the PAHC building and in Hepworth House at Drake Circus), Proteomics facility (Drake Circus), Movement and Function Laboratory (PAHC building) and Optometry clinical research rooms (Centre for Eye-care Excellence Clinic). (See section d, 'Income, Infrastructure and facilities' for detail)**.**

Areas of Refocused Investment: Prior to 2009, pedagogic research applied to the education of health professionals was a major interest for academic staff in the Schools of Nursing and Midwifery and Health Professions. This is now less of a priority and much activity in this area has moved to the School of Education and the Pedagogic Research Institute and Observatory (PedRIO) where specialist expertise will support higher quality pedagogic research (submitted to UoA25). The resource released by this has been re-directed to research activity in the CHeSCI Research Centre.

Integration and Collaboration with Clinical Practice.

This is crucial to ensure that research questions and research effort remain clinically relevant and that opportunities for impact are maximised. Strategies to enhance collaboration and integration include joint appointments of nursing professors that are planned with 4 NHS Trusts in the SW Region, and specialist clinics operated by research and clinical staff such as the primary care Dental Clinic. Clinical academics are appointed as research fellows to engage with research within CRTB and drive the translational and clinical research applications (eg Roberts in NIPD). Academic staff are also encouraged to seek NIHR funding for clinical fellowship awards that support the development of academic research careers in the clinical setting. Further examples are given in section e 'Collaboration and contribution to the discipline'. In addition, dedicated clinical research space has been included in the new third year optometry clinic (CEE) to provide a research base for practicing optometrists and ophthalmologists to engage with academic staff in clinical and practice research.

Various Honorary academic appointments of senior clinical staff have been made in all contributing Schools, for example Professor Nabil Habib, Consultant Ophthalmologist and Professor John Barbara, Director Transfusion services, in the Schools of Health Professions and Biomedical Sciences, respectively.

Researchers across the Unit contribute to undergraduate and postgraduate teaching, pursuing the research-led teaching agenda in support of strategic goal e above.

Research Organisation and Management through Research Institutes, Centres and Clusters.

The Faculty Research Committees are key bodies for research governance, reporting, and monitoring. In recognition of the substantial growth in health-related research, the Institute of Health and Community (IHC) was established in 2011 to act as a central focus for this Faculty activity. The research Centre directors (Endacott, Jackson**)** sit on the relevant Faculty Research Committees to ensure cohesion with and responsiveness of CHeSCI and CRTB to University Research policy, and they are members of the relevant Institute boards. The IHC takes a broad strategic remit for health and social care and through its 3 Research Centres (which include

CHeSCI) it manages and supports research in the health-related disciplines. Administrative support for research in UoA's 3, 22 and 25 is embedded within IHC through a team of 4 administrators headed by a Research Manager. ITSMed plays a similar role for biomedicine and clinical medicine and has research administrators and an NHS Engagement Officer. Both Institutes work closely with the Research Gateway specialist advisers and the Research Support and Development section within the University's Research and Innovation Division.

CHeSCI is the most significant IHC Centre for UoA 3 and supports the Allied Health Professions, Nursing and Midwifery, and Dentistry Research Groups. Biomedical Sciences research is similarly supported by CRTB, established in 2010, which has promoted the development of common research themes and interdisciplinary research projects and fostered close collaboration of researchers both within the Centre and with other groups in Plymouth and beyond. Research Ethics applications are handled either by the Faculty Research Ethics Committees or IRAS, as appropriate.

These developments support goals a-i.

c. People, including:

(i) Staffing strategy and staff development

The significant reconfiguration of research in this area since 2008 precludes any direct comparison with staffing levels at that time. It is clear, however, that the academic staff complement mapping to UoA 3 has increased substantially and now includes 10.0fte professors and 3fte Readers, with further professorial posts currently under active recruitment in line with strategic goals a and c above. In addition, a 5 year NIHR Clinical Fellowship was awarded to Paton in 2011. The total staff complement includes a significant number of non-research active teaching staff engaged to deliver professional health-related programmes. Our strategy has been to re-balancing the staff complement to significantly increase research capacity and quality in line with strategic goal c above. Accordingly, our recruitment strategy has been centred on attracting staff with established research credentials that are aligned to the themes of the research clusters as well as to our programme delivery requirements. This is evidenced by recent staff appointments in Biomedical Science that specifically support our research themes of infection and immunity (e.g. Fejer, Upton, Jarvis) and genomic and proteomic applications (e.g. Green, Lasonder, Belshaw). This recruitment strategy has been designed to ensure sustainability and to enable succession planning as required in strategic goal g. The recruitment strategy is complemented by an annual Performance Development Review of all staff in post. Academic performance and development needs are evaluated and objectives, including research goals, are set and monitored by reviewers. All academic staff are encouraged to engage actively with the transparent University academic promotions scheme, and those applying for promotion receive mentoring and support as required.

Specific forms of support for Research Staff through mentoring, staff development funds, workload allocation, and opportunities for study leave are differentiated by career stage:

Early Career Researchers (ECR's) are supported by assignment of an experienced research mentor (normally a professor) to identify and deliver specific support. This has been strengthened by the University's commitment to the Concordat to Support the Career Development of Researchers, for which the University received the EU HR Excellence in Research Award in 2011. The requirements of the Concordat are embedded in University HR policies, under which our ECRs have representation at Faculty and School Research Committee's and on Research Centre Management groups and where ECR's make a valuable contribution to policy and planning. Our ECR's also engage with a university-level Researcher Forum that provides training and support for ECR and Research staff and that provides additional opportunities for cross-faculty networking. They also elect representatives to the University Research and Innovation Committee. The transparent workload allocation systems pioneered in three of our Schools and being rolled-out across the university are designed *inter alia* to enable ECR research time to be protected in a context of overall fairness. ECRs are supported for attendance at national and international meetings and conferences for presentations and networking through School staff development funds. Specific guidance and mentoring in relation to the development of research funding, management, and dissemination skills are provided through CRTB and CHeSCI as appropriate, allowing ECRs to acquire these skills in relation to their engagement with a defined theme in their assigned Research Cluster. By involving ECR's in internal peer review processes for grant

applications, papers and conference proceedings, they learn their skills alongside experienced researchers in their specialism. CRTB has pioneered the provision of dedicated support for ECR grant writing through a 0.2fte post. Research Centres also fund participation in symposia/meetings and these are equally available to ECRs. University-wide workshops and seminars provide guidance on research management, governance and ethics. Good Clinical Practice (GCP) training is organised via local Hospital Trusts.

Mid-Career Researchers also benefit from the above support systems, where appropriate. In support of our rebalancing of the staff complement, those with no formal research training but who demonstrated significant research potential in RAE2008 have been encouraged to develop their research capacity through undertaking part-time PhD studies. This support includes full- or part-funding of registration fees and research costs, supervision, and protected study time. Currently 7 mid-career academics are undertaking PhD studies and recent completions include Parkin and White.

Experienced Researchers are encouraged to maintain and develop their research activity through national and international visits, provision of leave of absence for attendance at research, interest-group and grant provider meetings, and through sabbaticals. Research-Fellow support is also provided, on a competitive basis and Jackson, Avent, Purslow, Marsden, Sewell, Skirton and Richardson have benefitted from this since 2008. Senior researchers are encouraged to undertake key research leadership roles, for example Marsden and Endacott are Associate Heads of the School of Health Professions and Nursing and Midwifery, respectively, with responsibility for research. Senior researchers work closely with central staff in the University Research and Innovation Division, where dedicated support has been given for the preparation of grant applications and for knowledge transfer activities.

(ii) Research students:
The UoA currently has 14 doctoral completions in the REF period. Prior to 2012, subject-specific support was organised at School and Faculty level, and PGR students and their supervisory teams were encouraged to participate in an annual PGR conference. This activity has now transferred to the Research Centres as they have developed their capacity to provide support. This pooling of resources, skills, expertise and methodologies has created a new benchmark for the induction, preparation and supervision of PhD students. It provides an exciting and stimulating setting, bringing together students from different research clusters as peers with a common interest to share their findings, methodologies and experiences. Students also attend a range of research seminars organised by the Centres.

All PGR's are supported and monitored under the university-wide regulatory, procedural and support framework provided by the Graduate School. This includes approval of supervisory teams, which in the UoA often include colleagues from the NHS, student progress monitoring through log-book records, MPhil to PhD transfer reports, annual monitoring reports and student support. All PGR's in UoA3 engage with at least one support programme, for example writing skills, viva preparation, employment opportunities and, in the case of international students, language support. Student progress is monitored through regular reporting from the Director of Studies to School and faculty committees. The University is developing a devolved system of Doctoral Training Centres and there are plans to further augment academic support in Health and Biomedicine through Doctoral Training Centres aligned with our Institutes.

d. Income, infrastructure and facilities:

Research income for the Unit since January 2008 totals £3.18M. Significant organisational changes, the development of disciplines new to this University such as dentistry and optometry (see sections a and b), and the re-structuring of assessment sub-units combine to preclude meaningful comparison with the 2008 RAE submission. However, recent awards (e.g. £420K from the EU (Vlahou), £630K BBSRC (Jackson)) indicate the success of the strategy for continued growth in this area. There has, however been significant investment in research infrastructure and facilities since 2008 in several key areas:

Rehabilitation Research: Creation of a dedicated Human Movement and Function Laboratory

(78m^2), refurbished from existing space at PAHC at a cost of £50k, to house a range of previously donated equipment and the addition of new equipment to the value of £33k including an Fscan in-shoe and mat pressure system, transcranial magnetic stimulation equipment, an ultrasound unit and a computer-controlled motor to measure spasticity.
***Visual Sciences*:** Creation of Research Optics laboratory at PAHC (18m^2) and 3 research consulting rooms at CEE, each 7.5m^2 ,and dedicated equipment to the value of £114k, including; Tomey TMS-5 Topographer, Zeiss IOLMaster 500 (ocular biometry), Reichart Ocular Response Analyser, and a bespoke Adaptive Optics kit. This investment is focused mainly around the anterior-eye research interests being developed in the Visual Science cluster.
Biomedical Sciences: PU has invested £1.5M in the development of research facilities in biomedical science and CRTB has obtained state of the art systems biology facilities in proteomics (LC-MS Thermo orbitrap velos pro, difference in gel electrophoresis and associated robotics) and post genomics (next generation sequencing- Ion torrent PGM, and an expression profiling/digital PCR system (life sciences Quant studio)). It has also dedicated cell biology facilities (including BD FACS Aria 2 cell sorter, Luminex 200 multiplex protein detection platform). A biomedical Electron Paramagnetic Resonance (EPR) facility (Bruker EMX micro) has enhanced oxidative stress and oximetry projects. Cell imaging facilities will be further developed at the medical sciences campus during the relocation of CRTB.
Dentistry: has benefitted from a share of a £25M investment in medicine and dentistry by Plymouth University following the demerger of the Medical and Dental School.

Library provision has also improved since 2008, and all research staff and students have 24hour, 365days/year access to the main university library for research journals, subject-specific text books and PC workstations. Additional specialised library provision for Allied Health Professions and Dentistry are provided at the Northern Campus.

A lively seminar programme has been expanded through making the Research centres and Institutes the foci for organising internal and external speakers. Seminars are open to researchers from across the University and to those from the NHS and other key stakeholders. The Institute for Health and Community has a particularly important link with the Plymouth University of the Third Age, whose members regularly participate in workshops in such areas as ageing, diet, and health care.

e. Collaboration and contribution to the discipline or research base:

Collaboration with the Medical School in a peninsula-wide trans-disciplinary structure has been an especially important strategic aim and the creation of PUPSMD has allowed this cooperation to be built. This involves CRTB staff strengthening the basic science, translational science, and clinically facing networks and working closely with clinical and biomedical scientists submitted in UoA1. Examples are Lasonder working with Hanemann on proteomic analysis of brain tumours before and after therapy, Fejer collaborating with Cramp on Hepatitis C. immunity, Jackson working with Anichtchik on LPS and inflammation in Parkinson's Disease, and Avent working with Wright on non-invasive prenatal diagnosis. Members of the also unit participate in the €4.1Million CogNovo award from the EU Marie-Curie Training held by the School of Psycholgy (UoA4).Sewell's Kidani Memorial Trust grant of £182k has enabled him and CRTB staff to collaborate on projects ranging from chemotherapy dose-calculation and drug modulation to the environmental impact of chemotherapy medicines with Copplestone in the Medical school, Turner in Environmental Chemistry, and honorary Associate Professor Kaestner employed by the Plymouth CCG. This collaboration has led to a dose-banding strategy for cancer therapy that forms one of the impact case studies submitted in this unit. This collaboration, an RA and 3 PGR's (Liu, Fergusson and Vyas). A cross-Centre collaborative award for PhD studentships in cancer chemotherapy modulation has been awarded to Billington and Jackson (CRTB), Sewell (CHeSCI) and Copplestone **(**PUPSMD).

Beyond the University, our collaborations are regional, national and international:

Regional
Indicative examples include a Memorandum of Understanding with Plymouth Public Health and

Faculty of Health, Education and Society that has led to research collaborations on Breast Cancer Screening and Public Health Pharmacy (Sewell), and Jones's Knowlede Transfer Partnerships with Devon Partnership Trust and with Royal Devon and Exeter Hospital NHS Trust.

National

Prestigious Fellowships include an NIHR Clinical Fellowship for Paton, and a Fellowship *ad eundem* of the Faculty of General Dental Practice for Moles. Prizes include Nasser's Bill Silverman Award (2012) by the Cochrane Collaboration, ECR Bunn's receipt of the Gordon Holmes Prize (2012) of the Royal Society of Medicine, and Avent's receipt of the Kenneth Goldsmith Award by the British Blood Transfusion Society (2013). In national arenas Skirton chaired a Department of Health Working Group on competencies in genetics for Sickle Cell and Thalassemia nurses, Kay is Chair of Shirley Glasstone Hughes Trust Fund and a member of the NICE Public Health Advisory Committee, and Jackson is a member of the RSPCA Expert Group on sepsis and cell models of sepsis research

Staff undertake peer review for such schemes as NIHR Service Delivery and Organisation (Endacott, Moles, Richardson), NIHR Clinical Fellowships (Marsden and Sewell), NIHR In-Practice Fellowships (Moles), Wellcome Trust (Moles, Endacott), Medical Research Council (Richardson, Endacott), BUPA (Sewell, Richardson, Skirton), Economic and Social Research Council (Skirton), Cancer Research UK (Richardson, Skirton), and British Society for Oral and Dental Research (Moles). Nine academics serve on national Editorial Boards, including those of *Nursing Standard* (Endacott) and *Contemporary Nurse* (Endacott).

Eight full and short Knowledge Transfer Partnerships awards (KTP's) have been received, including Marsden's and Freeman's both with DM Orthotics Development, Richardson's with St. Lukes Hospice, and those of Jones noted above.

International

Skirton is a core member of the EU FP6 project EuroGentest that involves researchers from over 20 European countries. Nasser has collaborations with the Global Health Centre, University of Ottawa, Canada, and with the University of Melbourne, Australia. Fellowships and Expert Adviser awards include Endacott's Travelling Fellowship for the Intensive Care Society, Skirton's Visiting Professor Fellowship at Yamaguchi University, Japan, Endacott's Travelling Fellowship for the Isaiah Berlin Academy Study Group, Boulos as WHO Expert Adviser on 'Social Media and Web 2.0', and Richardson's position as an Academic Visitor at Yong Loo Lin School of Medicines, Singapore.

Fourteen academics hold Editorships in international journals, including Boulos as Editor in Chief of *International Journal of Health Geography*, Sewell as Associate Editor of *Journal of Oncology Pharmacy Practice*, and Jackson as Editor of *Innate Immunity Journal*. 26 staff serve as members of Editorial Boards including: Kay on *International Journal of Dentistry*, Endacott on *Intensive and Critical Care Nursing*, and Stenhouse on *Open Diabetes Journal* and *Midwifery*. Peer reviewing has been undertaken by Skirton for the Medical Research Council of South Africa and by Richardson for the Michael Smith Foundation, Canada.