Institution: University of the West of England, Bristol

Unit of Assessment: 3 - Allied Health Professions, Dentistry, Nursing and Pharmacy

a. Overview

This submission includes research from fundamental biomedical science and diagnostics through to the implementation and evaluation of novel patient care delivery. This return is from 54 academics (45.4 FTE and four Category C staff) whose research is organised in four well-established and integrated research themes: 1) *Biomedical Research and Diagnostics*; 2) *Appearance and Health*; 3) *Child Health*; and 4) *Long-term Conditions*. These research themes are strategically aligned to the following Research Centres within the University: Biosciences; Appearance Research and Health and Clinical Research, which provide research direction and infrastructure. The Centres have strong links with the University Institute of Biosensing Technology (IBST), which facilitates national and international collaborations and supports knowledge exchange with industry and healthcare providers. There is strong collaboration within and between these research themes and with staff returned to other UOAs, notably 6 and 22.
(The names of academics submitted in this Unit are highlighted in **bold**).

b. Research strategy

1. Achievements of strategic aims for research during the assessment period

A specific aim in the RAE 2008 was '*to maintain and build clearly identifiable areas of research strength in Biomedical Research and Diagnostics, Appearance and Health, Child Health* and *Long-term Conditions'*. In the period 2008-2013 the Unit has benefited from £6M investment by the University through its Strategic Research Development Fund. Through competitive calls, the following investments were made to support research in these areas: *i)* 52 postgraduate research studentships; *ii)* 6 post-doctoral research fellowships; *iii)* 10 awards for short-term funding to promote novel and productive collaborative research; *iv)* investment in the professoriate, through new appointments and career development leading to internal promotions (*see Section c, point i)*; *v)* investment in research equipment and facilities (*see Section d, points 3* and *4*). Additional investment through a UWE-wide scheme has provided funding of up to 12 months for 16 early career researchers, seven of whom are included in the submission (**May, Condon, Dures, Rajatileka, Robinson, Vahabi**, **Walsh**) and has led to prestigious awards of a five-year Arthritis Research UK fellowship (**Walsh**); a Leverhulme Fellowship (**Dures**) and successful NIHR grants (**Condon**) (*see Section d, point 1*). More generally, growth of strength across themes in both fundamental and applied research is evidenced by outstanding and highly accessed refereed papers. For example publications in the following journals: *Journal of Pharmacology* (**Alford**); *Cochrane Database of Systematic Reviews* (**Cramp F**); *Journal of Clinical Oncology* (**Rhodes**); *Journal of Chromatography A* (**McCalley**); *Sensors and Actuators B-Chemical* (**Ratcliffe**); *Journal of Cell Science* (**Ladomery**); and *Journal of Obstetrics and Gynaecology* (**Deave**). Also a recent paper published in *BMC Genetics* by **Varadi** has been accessed more than 600 times in the first month of its availability online.

The importance of '*developing across theme collaborations'* was also identified as a key aim in the RAE 2008 submission. One outstanding example of success in this is the effective collaboration between the themes *Appearance and Health* and *Child Health*. **Harcourt** in collaboration with **Towner**, and with the Universities of Bristol, Cardiff, Bath and North Bristol Trust, were successful in securing £1.5M funding from the Healing Foundation in 2011 to support the growth and development of a UK Centre for Burns Research of world-leading excellence. This work has led to a Fellowship funded by the Healing Foundation (£60K) and funding from a charity called "Restore-Burn and Wound Research" (£80K).

A further focus of the RAE 2008 strategy was 'to *strengthen and widen our collaboration with academia, NHS and industry, seen as important in responding to UK government, research council and European calls'*. A few examples of our successful collaborations are listed: *i)* **Hewlett** *(Long-term Conditions)* is leading an important randomised controlled trial that involves collaboration with clinical rheumatology teams in seven NHS Trusts (University Hospitals Bristol, North Bristol, Cardiff, Torbay, Weston, Chertsey, Poole), and the Universities of Bristol, Cardiff and Salford. Funded by a Health Technology Assessment grant, this work is addressing the impact of

rheumatoid arthritis fatigue through cognitive behavioural approaches (£1.4M total). The research was developed with patients involved as co-applicants and is *profiled in impact case study 6*. *ii)* **Salisbury** and **Anderson** *(Biomedical Research and Diagnostics)* in collaboration with Randox Laboratories Ltd., University Hospitals Bristol, Frimley Park NHS Trust, Cardiff University, Queen's University Belfast and Bristol Leukaemia Support Group, secured £369K MRC funding in 2011 to test for efficacy of combined drug chemotherapy. *This achievement is profiled in impact case study 1. iii)* **Ratcliffe** *(Biomedical Research and Diagnostics)* in collaboration with the University of Bristol has received income (£1.4M) from the Wellcome Trust, to develop a bedside device to detect microorganisms causing diarrhoea. *iv)* **Killard** *(Biomedical Research and Diagnostics)* with the University of Liverpool, Fraunhofer ENAS, VTT Finland and Alere, an international diagnostics company, obtained EU funding (£2.6M) to develop a Smart Integrated Miniaturised Sensor system (SIMS). This integrates printed and organic electronic technologies to create a device capable of measuring species such as cholesterol. *v)* **McCalley** *(Biomedical Research and Diagnostics)* in collaboration with GlaxoSmithKline has received funding from the EPSRC (£300K) for a CASE student and a postdoctoral researcher to develop novel analytical methods to improve current chromatographic procedures used in the pharmaceutical industry. *vi)* Two further industry supported CASE studentships were awarded (**Varadi**, **Ratcliffe**) that are profiled in section c, point ii). *vii)* The Unit was awarded a BBSRC Doctoral Training Account (£217K) (**Varadi** co-applicant), and a successful student was supervised by **Conway** (*Biomedical Research and Diagnostics*).

An additional aim of the RAE 2008 submission was '*to ensure the relevance of our work to industry, healthcare and society at large'*. Further to the successes mentioned in the previous paragraph **Roulstone** *(Child Health)* secured the single largest funding, a 'Better Communication Research Programme grant' (£1.2M), to speech and language impairment from the Department of Education. This collaborative work with the Universities of Warwick, Newcastle and London produced a series of reports discussed in the House of Lords, which were included in an All Party Parliamentary Group report (2013) on children with speech and language impairment. *This is profiled in impact case study 4*. To further strengthen the relevance of the Unit's research we have developed an additional leading-edge and overarching area namely patient and public involvement in research. Led by **Evans**, this area of excellence includes a consortium of six NHS organisations in Bristol and Bath to support public involvement in research (£100K contributed by consortium members) and secured NIHR monies to evaluate the impact of patient involvement in research (NIHR, £187K). Collaboration with industry has also been supported by two UWE-led European Regional Development Funding initiatives: the Biomedical innovation Network (iNet, 2.2M euros) and The Centre for Alternative Testing and *in vitro* Monitoring (CATIM, 1.8M euros). Both are designed to support growth in industry by promoting interaction with academics to drive innovation within the company and enhance product development.

2. Future strategic aims and goals for research

The Unit vision is to *deliver excellent user-informed research which generates new scientific knowledge*, *and leads to improvements and positive impact on the health and wellbeing of society*. To achieve this, the Unit's five-year strategic plan, which reflects the University strategy, is the following:

- On-going development of established and emergent areas of research excellence, which address national, international, industry and health priorities and will ensure long-term sustainability;
- Maintaining and strengthening our external partnerships with academia, industry and healthcare providers;
- Undertaking collaborative projects which focus on addressing stakeholder needs and maximising the adoption and diffusion of innovation and commercial potential of research findings;
- Strengthening our relationship with patients and the public to ensure their involvement in our research activities;
- Targeted investment in staff and infrastructure to support excellent research;
- Research capacity building to ensure our talented early career researchers and research students are well placed to lead future research excellence;

- Making a positive contribution to our student experience through the integration and dissemination of our research findings into undergraduate, postgraduate and professional curricula.

3. How we will achieve this

i) *Sustained development of research* - Key areas of research excellence are being maintained and developed through a number of initiatives. One such example is the establishment of Bristol Health Partners (BHP), developed from the Bristol Research and Innovation Group for Health collaboration started in 2008. The collaborators include UWE, the University of Bristol, local NHS Trusts and Bristol City Council. Bristol Health Partners' main strategic priority is to develop excellent multi- and/or interdisciplinary research that translates into practice and education. This is being developed through Health Integration Teams which are cross-organisation interdisciplinary groups set up to harness research, innovation, education, to tackle major health priorities by working together in new and different ways. Several academics included in this submission (**Conway, Cramp F, Deave, Fletcher, Gray R, Harcourt, Hewlett, McCabe, Mytton, Palmer, Rumsey**) are members of the Health Integration Teams related to '*Long-term Conditions*', '*Mental Health*' and '*Child Health*' (*see Section e, points 1 and 3*). Bristol Health Partners has informed both the successful West of England Academic Health Science Network (WEAHSN) and Collaboration for Leadership in Applied Health Research (CLAHRC*west*) applications. Recent funding from the NIHR of £9 million for five years, along with matched funding from the collaborators (£9M), will support the work of the BHP Health Integration Teams across the region.

The maintenance and development of patient and public involvement in research features in our new strategic plan and is present in most of our research activities. We take an inclusive approach and involve service users and carers in developing research bids, research delivery and dissemination. Our national standing in this area has been used to inform and lead the development of patient and public involvement in BHP, WEAHSN and CLAHRC*west (see previous paragraph)*. We lead the evaluation (**Moule**), public involvement (**Evans**) and education (**Gray S**) themes within the CLAHRC*west* (*see Section e, point 3*). New research activity in *Mental Health* sciences is strengthened by a recent professorial appointment (**Gray R**) and the relocation of his research team from the University of East Anglia to UWE.

Bio-markers for Alzheimer's disease (**Conway**) and bio-luminescent detection of best chemotherapy treatment for cancer (**Salisbury**) were identified as research that will have a profound effect on our future among the 100 '*Big Ideas for the Future'* Research Council UK 2011 publication. Diverse aspects of Alzheimer's diseases, from blood biomarkers (**Conway**) to cognitive biomarkers (**Alford**), are being investigated in an interdisciplinary collaborative effort and warrant our growth of this priority area of research. The recent appointments of three early career researchers (**Anderson**, **May** and **Robinson**) to continue **Salisbury's** pioneering work and the expansion of the bio-luminescence technology to detect pathogen invasion and survival (**Davenport**), will ensure that this line of research will be maintained and advanced.

An early career researcher (**Vahabi**) was appointed jointly with the Bristol Urological Institute (BUI, North Bristol NHS Trust) to develop an organ bladder model. The ability to investigate the aging bladder function in an experimental organ model provided us with a window of opportunity to secure funding from Pfizer and to respond to the BBSRC priority area on 'Aging across the life-course' (Studies of the aging bladder) call. We will nurture this area and the recent move of **Ellis-Jones** from the BUI is an important development in this respect.

Genetic screening/testing which addresses one of the four priority research areas of the World Health Organisation, i.e. Human Genetics, will be further developed. Strategic investment has been made to develop genetic screening/testing to detect: *i)* white matter brain injury in premature newborns in collaboration with North Bristol NHS Trust Bristol Genetics Laboratory and the University of Bristol and *ii)* inherited haemoglobin disorders in collaboration with Sheikh Khalifa Medical City, Abu Dhabi, United Arab Emirates (**Varadi**). **Rumsey** is involved in a cleft lip gene bank and birth cohort study drawing on Avon Longitudinal Study of Parents and Children (ALSPAC) data. This provides an opportunity to develop genetic testing with the potential for national/international impact.

Future biosensing research will focus on the area of biomedical diagnostics, which will include the

development of functional nanomaterials to allow sensitive and selective detection in miniaturised devices such as blood coagulation monitoring, analysis of volatiles in breath, urine and faeces (**Killard**, **Ratcliffe**). The importance of nanotechnology to sensors, for miniaturisation and reducing costs to enhance disposability is recognised in the government document, '*Innovation and Research Strategy for Growth 2011'*. The use of biofilm models for oral malodour research led by **Greenman** is strengthened by the promotion of **Saad** to Research Fellow. Research into the molecular pathways responsible for progression and metastatic spread in prostate and breast cancer (**Rhodes**, **Ladomery**), in collaboration with the University of Bristol and the University of Malaya Medical Centre, will be further developed. Novel cancer biomarkers based on devices that can detect volatile tumour associated compounds (**Ratcliffe**) and microRNAs (**Killard**, **Ladomery**) will be taken forward. Present collaboration with the pharmaceutical industry will be strengthened by new approaches to research to establish analytical methods that can be applied routinely in a tool-box approach for "difficult" (mostly polar) compounds in pharmaceuticals (**McCalley**), an area of increasing importance for recent drug formulations. The intention is to support these promising research areas through future strategic investment such as funding of PhD students, Research Associates, Research Technicians and new academic appointments; supporting sabbatical leave, and hosting researchers from other organisations (*see Section ii*).

ii) Responding to priorities and initiatives – In addition to the projects that we developed recently (outlined in the previous section) our strategy is to obtain further resource to address funder priorities in areas where we have a track record of success including: NIHR, MRC, ESRC, EPSRC, BBSRC, European Commission, industry and a number of key charities such as The Wellcome Trust and Arthritis Research UK. We also aim to increase our links and collaborations with industry and other end users through the Institute of Biosensing Technology (IBST), the UWE-hosted innovation networks (iNETS) and CATIM. This will lead to the development of new systems for *in vitro* studies and participation in Knowledge Transfer Networks (e.g. Biosciences KTN, Instrumentation KTN). These links will support funding applications to Horizon 2020, Technology Strategy Board, Research Council industry-related schemes.

iii) Promotion of research activity, culture and dissemination – Within and across the four research themes there is an increasing drive to maximise effective strategic collaborations leading to external income generation, publications and other outputs, and impact. The University's Strategic Research Development Fund provides resource to support a number of aims including: promotion of novel and productive collaborative research; maximising opportunities for knowledge exchange; supporting the research culture; maintaining and enhancing the number of externally and internally funded postgraduate research students (currently 17 and 28 respectively). We also make judicious visiting appointments at Professorial and Research Fellow levels (currently 5 and 15 respectively) (*see Section e, 1.*). These strategic appointments support collaborative grant applications, PhD supervision and publications. In addition, the themes intend to expand and support the exchange of staff to enhance national and international research collaborations. Planned, future academic appointments will also enhance our research portfolio. A programme of monthly research seminars is open to all academics and students. The aims are to facilitate collaborations and inform the development of both undergraduate and postgraduate students. In addition, academic staff are funded to present their research at international and national conferences. Research will also be disseminated to industrial audiences through technology showcases and via Medilink South-West, successor to the Biomedical iNet. IBST will continue to organise workshops in partnership with industry organisations, such as the Sensors in Water Interest Group and Photonex, as well as the Technology Strategy Board KTNs (e.g. Health Technologies and Medicines, Electronic Sensors Photonics) at which researchers are invited to promote research activities to industry.

iv) Development of infrastructure – The Unit's research has received internal and external investments in infrastructure (*see section d*). We will continue to ensure that future investment is driven by strategic priorities to ensure existing and emerging key areas of research are supported and to maximise opportunities for shared resource use. In addition, where available we will continue to take opportunities to use existing local and national resources, such as the Wellcome Trust sequencing facilities at the Sanger Institute, Cambridge.

c. People, including:

i. Staffing strategy and staff development

1. Support of early career researchers, internal promotions and new appointments

The Unit has worked to ensure succession planning, and strengthening of industry and clinical practice links through the development and promotion of internal staff and a number of new strategic appointments. Some of these new staff maintain clinical practice to maximise the potential to undertake research with a clearly defined clinical need (**McCabe, Gray R**). Thirteen early career researchers are returned in this submission as part of our succession planning **Saad**, **May**, **Rajatileka**, **Robinson** and **Vahabi** (*Biomedical Research and Diagnostics)*, **Condon** (*Child Health*) and **Brant, Brown**, **Sanderson, Dures, Bray, Ellis-Jones** and **Turton** (*Long-term Conditions*). Examples of former early career staff who were supported in the REF period (2008-2013) and have made a significant contribution to this submission as key researchers include **Conway** and **Davenport** (*Biomedical Research and Diagnostics)*.

Further investment has been made through new academic appointments at senior lecturer level (**Mansell**, from the University of Bristol (*Biomedical Research and Diagnostics*); **Cramp M**, from the University of East London (*Long-term Conditions*) and professorial level (**Killard,** from Dublin City University (*Biomedical Research and Diagnostics*); **McCabe,** from the University of Bath; and **Gray R** from the University of East Anglia (*Long-term Conditions).* Internal professorial promotions are **Rhodes, Varadi, McCalley** (*Biomedical Research and Diagnostics*), **Harcourt** (*Appearance and Health*), **Evans, Moule**, **Palmer** (*Long-term Conditions*), and **Fletcher** (*Child Health*). Internal promotions to Associate Professor are **Conway** and **Ladomery** (*Biomedical Research and Diagnostics),* **Moss** (*Appearance and Health*), **Deave** and **Mytton** (*Child Health*), **Albarran**, **Cramp F** and **Walsh** (*Long-term Conditions*). *Appearance and Health* has also benefited from the appointment of a new Senior Research Fellow (**Persson**). **Lyttle** is a recent visiting appointment from the University Hospitals Bristol NHS Foundation Trust, strengthening the *Long-term Conditions* theme. Staff promoted within the Unit were all returned to four different Units of Assessment in the RAE 2008.

Of the new appointments, **Anderson, May, Robinson** and **Vahabi**, strengthening the *Biomedical Research and Diagnostics* theme, are discussed in *Section b, 3, point i*. The appointments of **Sanderson, Cramp M, Mansell** and **Dures** support existing musculoskeletal research, **Ellis-Jones** brings urodynamics and nursing expertise, and **Bray** and **Brown** bring expertise in Mental Health, all linked to *Long-term Conditions*. The appointment of **Condon** brings public health perspectives on Gypsy and Traveller populations contributing to continuing research in *Child Health*. These appointments are part of a strategy to ensure on-going vibrant research in the Unit and are linked to our established and emerging areas of research strength. Succession planning for *Biomedical Research and Diagnostics* has included the appointment of **Killard**, replacing professorial expertise in this area. **Killard** brings expertise in the fabrication of sensors and diagnostics around industrial and biomedical applications. **McCabe** and **Cramp M** enhance *Long-term Conditions* and links to *Biomedical Research and Diagnostics Sciences* (**Alford**), bringing strengths in pain sciences and chronic pain. **Gray R** introduces a new field of *Mental Health* research to the Unit in adherence, schizophrenia and dementia, which relate to health priorities regionally (Bristol Health Partners, *see Section b, 3 point i*) and nationally. **Persson** is employed to support the work on cleft palate in *Appearance and Health,* and brings key European expertise through his collaborations such as University of Kristianstad, Sweden and Universidad Autonoma de Madrid, Spain. **Mytton** was a Senior Research Fellow and Consultant in Child Public Health before her successful promotion and employment as Associate Professor. The appointment strengthens *Child Health* through research interests in public health and risk avoidance and is part of succession planning for **Towner**, along with the promotion of **Deave**. The promotion of **Saad** to Research Fellow provides succession planning for **Greenman,** supporting *Biomedical Research and Diagnostics*. An appointment has been made from the University of Manchester to the Underwood Trust Professor of Language and Communication Impairment in preparation for the retirement of **Roulstone**.

All newly appointed academics and those with visiting arrangements are members of one of our

research centres to ensure the effective integration, development and support of staff. Our existing infrastructure fully supports the Unit's research activity. Recent investment was specifically made to develop infrastructure to facilitate new research, for example the establishment of a specialised lab for bio-sensing research (**Killard**) (*see Section d, 4*).

2. Staff development and support

The Executive Dean for the Faculty, advised by the Associate Dean for Research & Innovation, has overall responsibility for staff recruitment and research development. All early career researchers are supported in the following ways: i) All new research staff are allocated a mentor to support transfer to the university and aid the development of research capability; ii) An early career research fund provides support for the development of research bidding activity; iii) Specialist training and mentoring are provided to support bid preparation, project management, financial and risk management.

All staff receive induction/early mentorship, appraisal and support for career development. A performance and development review (PDR) of all staff is used to inform career pathways for research as well as other activities, in line with strategic priorities. The effective annual PDR process led to the internal promotion of **Albarran, Conway, Cramp F, Evans, Harcourt, McCalley, Moule, Palmer**, and **Walsh.**

The principles of the *Concordat to Support the Career Development of Researchers* (2008) have been actively implemented by the Unit with University support and in line with strategic University priorities. A comprehensive 'gap analysis' was undertaken which reviewed all the relevant policies and procedures in place in comparison with those principles. Recommendations on how to enhance the support for researchers was set out in an action plan which was approved by the University's Research and Knowledge Exchange Committee. The European Commission recognised UWE's progress on supporting the career development of researchers through the Human Resources Excellence in Research Award, granted in 2012. We are currently working towards an interim review in early 2014 which will re-confirm the recognition of this award. The Researchers' Forum, established in 2005, is one example of good practice. It provides a network for all research staff to be informed about UWE's research strategy and relevant policies. This vibrant forum facilitates the sharing of good practice across the University and provides development events specifically to support career aspirations. A second example is the opportunity for post-doctoral staff to obtain independent research funding for up to one year which enables them to successfully apply for personal fellowships and external grant funding (**Walsh, Dures, Condon**). Several of our researchers have been successful in obtaining academic positions at the University (**Anderson, May, Robinson, Vahabi**) (*see Section b, 1, point iii*). Staff also benefit from working as part of an inclusive workplace, recognised in the Stonewall Workplace Equality Index Top 100 (2013) where UWE is the third highest ranked UK University.

Additional support for women researchers is provided in the Unit as part of the University Women Researchers Mentoring Scheme. This scheme supports women to strengthen their research portfolios in order to achieve senior research positions and has enabled three women in the Unit to achieve early career research grants (**Condon, May, Vahabi**). The Unit includes 61% women, 10 of whom are part-time and three who have had periods of maternity leave in this REF cycle. Work undertaken to support women researchers in the Unit informed a recent successful Athena SWAN application for a University and a Department Bronze award (the latter being led by **Varadi**).

ii. Research students

The Unit aims to provide an exemplary training, support and learning environment for its postgraduate research (PGR) students, and draws on the UWE Graduate School and Code of Practice for Postgraduate Research Study in this work. During the assessment period there were 95.1 FTE student completions (see REF4a). Currently, the Unit supports 54 doctoral students, including ten people on externally funded studentships from FP7 European Framework, BRACE (funding research into dementia), Arthritis Research UK, UNICEF, Breast Cancer Campaign, Changing Faces, and UH Bristol. In addition, we were awarded three industrial CASE studentships (AstraZeneca MRC, GlaxoSmithKline EPSRC and Airbus EPSRC). A number of our former doctoral students are employees in the NHS and academia. For example, one doctoral graduate

holds a prestigious research directorship role in a local NHS Trust. Four doctoral graduates have secured Lectureships or Research Fellow roles. A further graduate has successfully started her own company "Bright Sparks". As a result of its strong international reputation, the Unit is a popular place for self-funded doctoral students to study with 9 currently being funded in this way. In this REF period, we have hosted PGR students from countries including the United Arab Emirates, Kuwait and Libya.

Every PGR student has a supervisory team comprising a Director of Studies plus one or more Supervisors (often from industry or another HEI, including Bristol, Cardiff, Plymouth, Bath). PGR students are also supported by the Faculty Director of Postgraduate Research Studies (**Cramp F**). The UWE Code of Practice for Postgraduate Research Study is closely aligned to the QAA Code of Practice that includes the requirement for annual progression reports from the student and the supervisory team, and a viva at the end of the first year of full-time study (pro-rata for part-time students). All students placed at UWE are members of a research centre. Students are required to attend the programme of seminars given by external speakers. They must also present their work as internal speakers at the annual Postgraduate Forum, as part of a 60 credit Research Training and Professional Development element of doctoral training. Furthermore, they are expected to actively participate in an annual review day to showcase research activity, organised by their Research Centre. Laboratory based research students have dedicated bench space and individual work-stations in designated postgraduate rooms or areas. They work alongside post-doctoral researchers. Internationally located students are supported through regular virtual discussions, as well as having face-to-face support and delivery as part of an on-going programme of staff visits. All PGR students are members of the UWE Graduate School launched in 2012. This provides a supportive environment from application through to graduation, offering a range of bespoke services to meet individual needs. This includes a training and development programme for students and supervisors designed to map to the Vitae Researcher Development Framework. The Graduate School also provides networking events and access to regional and national support. PGR students have opportunities to gain experience in research laboratories abroad via the Marie Curie International Exchange Scheme. Our PGR students were successful in obtaining prestigious awards in 2012, such as; the Arthritis Research UK prize for best oral presentation at the Annual Fellows Day, the poster prize at the British Society for Rheumatology Conference and the European Society for Separation Science. Further national prizes include, the Health Services Journal Challenge Award (2011) and the Nursing and Practice Award for Mental Health (2010) and the Igor Stojiljkovic Memorial Award Travel Scholarship (2010) to support conference attendance.

The Unit offered summer research placements to 33 undergraduate students in the last three years. These have been funded by ten different external funding bodies including the Wellcome Trust. This initiative introduces interested students to research at the earliest stage of their career.

d. Income, infrastructure and facilities

1. Research income during 2008-2013

The Unit's research funding in this period totals £10,232,910, as detailed in REF 4b. Funding comes from Research Councils (MRC, EPSRC and BBSRC), government departments (NIHR, Education), charities (Wellcome Trust, Arthritis Research UK, BRACE, Healing Foundation, RESTORE Burns and Wound Research), industry (GlaxoSmithKline, Randox, AstraZeneca), the European Union (FP7 Grants, Marie Curie Inter-European Fellowship), and other international organisations (Clavis Pharma AMA, Colgate-Palmolive, Proctor and Gamble, World Health Organisation, European League Against Rheumatism, UNICEF Bangladesh) There have been particular successes with NIHR grant funding, especially collaborative projects with NHS colleagues and collaborative Knowledge Transfer Partnerships, e.g. with Great Western Ambulance Service led by Loughborough University (**Benger**). The Unit received funding totalling £394,588 from the Bristol Urological Institute, for collaborative work in the areas of prostate and bladder cancer. This funded a Research Technician, part-time Lecturer and PhD studentship. Prestigious external income has led to a number of high quality outputs and impact. One example includes the collaboration with AstraZeneca and the MRC (funding of £101,939 supported an industrial collaborative studentship working on Lipotoxicity in pancreatic beta-cells), which led to an internationally excellent publication in one of the top journals in endocrinology and metabolism (**Varadi**). Collaborative working with Randox Laboratories supported by the MRC led to the

submission of a patent and a number of internationally excellent publications (**Salisbury**). The fabrication of a novel blood coagulation assay supported by an EU FP7 grant (**Killard**) and work on rheumatoid arthritis funded by the NIHR (**Palmer**), led to publications in leading journals in their respective research fields**.**

2. Research donations

Child Health research benefits from a significant private donation of £1.2M to support speech and language therapy research over the next decade. This is being used to fund half of the costs of a professorial post (**Roulstone** until 31.12.13, new appointment from 01.02.14) and will underpin the future appointment of a Senior Research Fellow. Research undertaken has contributed significantly to a growing political appreciation of the crucial role that language plays in a child's development (*as evidenced in impact case study 4*). In *Biomedical Research and Diagnostics,* **Rhodes**, with collaborators from North Bristol Trust and the University of Bristol, secured donations from the John James Foundation and the Friends of Bristol Haematology and Oncology Centre, which together with matched funding from HEFCE totalled £180K. These donations were used to purchase a Veridex Circulating Tumour Cell (CTC) instrument and to provide technical support to run the system. This equipment is housed in the Department of Clinical Sciences at Southmead Hospital, Bristol and provides vital facilities for on-going clinical trials and investigations into metastatic tumour cells.

3. External investment in infrastructure

In *Biomedical Research and Diagnostics*, **McCalley** received $145K investment in High Performance Liquid Chromatography (HPLC) equipment sponsored by the US based Agilent Technologies. This supports collaborative research with the company and led to two joint publications which improved our understanding of rapid separation methods at high pressures for the analysis of pharmaceuticals and clinically relevant compounds in biological fluids. CATIM, established in 2012, was funded (2M euros) by the European Regional Development Fund.

4. Internal investment in research infrastructure

Investment in the Human Analysis Laboratory includes equipment totalling £305K (10 camera Qualisys system, synchronised with a Kistler force platform and an eight channel electromyography system). This facility runs a sports therapy clinic throughout the year. Two academic staff support the facility and aim to increase provision and income in sports screening and development of a new patient base. A £3.2M investment in general laboratory refurbishment has significantly benefited our biomedical research. It includes Class 2 laboratories for microbiology research, dedicated microbiology and media preparation rooms, flexible dark rooms for low light research and a separate dark room, autoclave room and two research labs, one of which is dedicated to malodour research. Further investments in 2012 have included £125K to convert existing general laboratory space into a dedicated Sensor Suite, comprising five rooms housing specialist equipment. Major items include two DEK 248 semi-automated printers to print conductive tracks for sensors and electrodes and for aligning printer layers and atomic force/scanning electrochemical/scanning tunnelling microscopy for characterising electrochemical surfaces. The laboratory allows for the integration of various sensors into functional devices and systems, for example, for disease diagnostics. In addition, the Unit has invested £535K in research equipment (e.g. Accuri flow cytometer, E-scan EPR spectrophotometer, high resolution gas chromatography, fluorescent photomicroscope, real-time PCR system, software for biomarker identification and ink jet printing system) for biosensing research.

The Unit provided £11K in 2011 towards the set up of the Pain Research Laboratory services based at the Royal National Hospital for Rheumatic Diseases, Bath (through **McCabe)** and provides continuing support through an annual investment of £5K. An Academic Rheumatology Unit at University Hospitals Bristol is supported with £5K annually (through **Hewlett**). Both collaborations have been successful in securing research income, developing research capacity including doctoral students and fostering patient and public involvement in research. In particular collaborations around the patient perception of the disease of Rheumatoid Arthritis have been embedded within the Outcomes Measurement in Rheumatology Clinical Trials (OMERACT) international expert group, of which **Hewlett's** team is a major contributor (*as evidenced in impact case study 6*).

5. Research governance

Unit staff are able to access well-established policies and structures for ethical review of research. Researchers working in the Health Service are also able to obtain advice and guidance on external ethics review processes, Research Passports and NHS Research and Development from the Faculty Research Ethics Committee and the Research Administration team. All clinical trials are managed in accordance with good practice guidance and staff are informed by a Clinical Trials Working Group (led by **Gray R**). Additionally there is a Human Tissue Working Group (led by **Greenman**) which advises staff on the use of human tissue in research, assists in ensuring compliance with the Human Tissue Act and promotes best practice. Recent attention has focused on reviewing and updating the University's data protection policies as they relate to research, and developing a strategy for data management through the work of a Joint Information Systems Committee-funded project. A new Research Governance Manager will be appointed shortly in Research Business and Innovation who will provide an additional resource to support researchers and deliver good research governance. UWE has a peer review college to scrutinise grant applications to Research Councils.

e. Collaboration or contribution to the discipline or research base

The Unit works to ensure that it maintains strong research partnerships needed for collaborative research. Many of the mechanisms in place to support external collaboration are described in detail within the Impact template (*see Section b*). Our plans to respond to national and international priorities and initiatives are detailed earlier (*see Section b, 3*).

1. Collaboration within academia: We have strong collaborations with local Universities of Cardiff (**Harcourt, Hewlett, Ladomery, Towner, Varadi**), Bath (**Harcourt, McCabe, Towner**) and Bristol, partly supported through Bristol Health Partners (*see Section b, 3, point i*). We have a wide range of international university collaborations which is evidenced by our publications. A few examples of collaborative papers are published in the following journals: *Journal of Communication Disorders* (with Charles Sturt University, Australia); *Annuals of Rheumatoid Disorders* (with Stanford University, USA); *Cancer Cell*, (with University of Southern California, USA and Kyoto University, Japan) and *Schizophrenia Research* (with University of Bern, Switzerland). The Unit supports and hosts a number of visiting appointments. **Rhodes** is Visiting Professor to the University of Malaya and supervised PhD students as part of a wider Memorandum of Understanding for Research Collaborations which led to further research funding from Malaysia and publications. **Killard** was appointed Adjunct Professor at the Biomedical Diagnostics Institute, Dublin in October 2011, where he currently leads a research team. This collaboration has led to several internationally excellent publications. The Unit has hosted a number of academics/researchers from international institutions. Examples of these include: Professor Susan Paxton (LaTrobe University, Melbourne) who jointly supervised Dr Zali Yager, Leverhulme Fellowship, 2011-2012, with **Rumsey**; Professor Sharynee McLeod (Charles Sturt University, Australia) worked with **Roulstone** in 2010 and 2012, this led to the co-production of a book, joint publications and a successful bid for a large randomised trial to the Australian Research Council. Professor Joris Verster (Utrecht University, The Netherlands) worked with **Alford** in 2012 and 2013. This led to publications and two research projects with postgraduate students arriving from Holland in 2013 to continue this work. Professor Ulrich Bummer (University of Wollongong, Australia) worked with **Varadi** in 2011 and published their collaborative work in Diabetologia, one of the top journals in the area of Endocrinology and Metabolism.

Our collaborations have supported opportunities for joint working and funding. The COST (European Cooperation in Science and Technology) network led by **Rumsey** has 23 European partners and the Leonardo da Vinci Scheme involves six partners. Both projects co-ordinate and increase research across Europe for patient benefit. Further examples include: **Ladomery** is a member of PROSENSE, a 5 year EU-funded Marie Curie ITN network to promote biosensing in prostate cancer involving a number of local clinicians. **Towner** is advisor to the Centre for Injury Research and Prevention in Bangladesh and has provided support for one PhD student funded through UNICEF who will return to work in the Centre.

2. Collaboration with industry: The IBST European-funded Biomedical iNet, has engaged with over 382 South West SME companies in the biomedical, health and medical technology sectors supporting innovation. This has allowed researchers to directly support the development of

innovation and the growth of SMEs such as Nanosight and Taste Tech, both of which won national awards following iNet support. **Ratcliffe** advised on volatile sensing and **Killard** on printed electronics. In addition to SME collaboration through the iNets, researchers engage with larger companies and organisations such as the Defence Science and Technology Laboratory (**Ratcliffe**) and Randox Laboratories (**Salisbury** and **Anderson**)**.** Another effective support mechanism for collaboration is CASE studentships (*see Section b, 1*).

The Unit has extensive collaboration with industry (**Killard, Greenman, Varadi, Salisbury, Anderson, Ratcliffe, McCalley, May, Robinson, Saad, Pemberton**) which includes Johnson and Johnson, GABA International, GlaxoSmithKline, Colgate Palmolive, Philips Research Laboratories, Astra Zeneca, Pfizer, QinetiQ Ltd, Applied Enzyme Technology, Gwent Electronic Materials Ltd, Uniscan Instruments Ltd, Airbus and Bradtec. Many of these collaborations have resulted in joint grant applications and publications (*see Impact Template, Section b, ii and Section d*).

3. Collaboration with healthcare professionals: Academics in the Unit are supported to hold clinical appointments that enable them to collaborate widely with practice colleagues, examples include; **Gray R, Hewlett, McCabe**. There is strong collaborative research with staff working on joint projects with a range of NHS Trusts. These include University Hospitals Bristol (**Albarran, Anderson, Benger, Brant, Conway, Davenport, Deave, Fletcher, Hewlett, Ladomery, Lyttle, Ratcliffe, Rhodes, Salisbury, Towner, Turton**), North Bristol Trust (**Anderson, Conway, Ladomery, Ratcliffe, Roulstone, Salisbury, Turton, Vahabi, Varadi, White**), Royal National Hospital for Rheumatic Diseases, Bath (**Lewis, McCabe**), NHS Bristol (**Moule, Mytton, Turton, Walsh, Wren**) and Avon and Wiltshire Mental Health Partnership Trust (**Gray R, Brown**). Collaborations include a dedicated Knowledge Transfer Partnership project, such as one with Great Western Ambulance Service led by Loughborough University (**Benger**). **Rumsey** currently leads the Global Task Force on Holistic Outcomes in Cleft which includes representatives from 70 countries who are implementing methods of auditing psychological adjustment to cleft and its treatment, based on her research.

Staff from the Unit play key roles in leading peer-approved Health Integration Teams within Bristol Health Partners (*see Section b, 3, point i*) including; musculoskeletal (**Cramp F, Cramp M, Hewlett, Palmer, Walsh**), children and young people (**Benger, Fletcher, Deave, Mytton**), dementia (**Conway, Gray R**), preventing hospital admission (**Benger**), self-harm (**Benger**), supporting healthier neighbourhoods (**Gray S**). In addition, staff provide leadership and support in public involvement in research (**Evans**), capacity development (**Gray S**.) and evaluation (**Moule**) as part of the successful Collaboration for Leadership in Applied Health Research (CLAHRC*west*) (£18M total including matched funding, £9M from NIHR). Staff also hold key roles in the WEAHSN with **Evans** leading the public involvement theme.

Unit staff are involved in teaching and research programmes at undergraduate and postgraduate levels relevant to NHS staff development. In addition, the Doctorate in Health and Social Care is delivered in Hong Kong (**Albarran, Cramp M**).

4. Collaboration with patients and the public: The Unit has a distinguished record of engaging the lay public in its research. This happens in a number of ways, e.g., i) **Rhodes** and others have secured funding to support a series of conferences in which lay public user involvement is a key initiative, such as Prostate Cancer in the South-West (2009); ii) A number of researchers have strong public involvement groups informing their research (**Evans**, **Hewlett, McCabe, Roulstone, Rumsey, Towner, Walsh**).

5. Externally recognised roles and activities: A significant number of staff are recognised for their expertise and review for a number of funding bodies. **Killard** and **Varadi** were evaluators for the EU Framework Programme 7. Further reviewing activity includes: US NSF (**Killard**); Research Charities (**Hewlett, Ladomery, Ratcliffe, Rumsey**); NIHR (**Hewlett, Pollock, Fletcher, Evans, Benger**); ESRC (**Evans, Moule, Rumsey**); BBSRC (**Alford, Ladomery, Varadi**); MRC (**Ladomery, Ratcliffe, Varadi**); EPSRC (**Killard**). **Hewlett** reviews grants for the Canadian Government. **Albarran** has acted as reviewer for the Irish Health Research Board and for the Australian College of Critical Care Nurses and the Alberta Heritage Foundation, Canada.

Staff make a contribution to their discipline through providing scientific advice to a range of

committees and through keynote addresses. For example: **Rhodes** is a member of the American Society of Clinical Oncology and College of American Pathologists; **Rumsey** was the British Psychological Society Consultant to the Department of Health (2008-2010) and provided expert evidence to the All Party Parliamentary Campaign on Body Image (2012) and the Royal College of Surgeons Standards for Cosmetic Practice; **Alford** gave expert evidence to the UK Committee on Toxicity; and **Evans** is a member of the NIHR INVOLVE Advisory Group, supporting public involvement in the NHS.

Staff have given keynote lectures with notable examples including: **Ratcliffe** 2010 Breath Analysis Conference, California; **Varadi** 2011 16th International Symposium on Chromaffin Cell Biology, Beijing China; **McCalley** 2012 HPLC conference Balitmore USA; **Ladomery** 2012 European Organisation for Research and Treatment of Cancer, Slovakia; **Persson** European Parliament, Brussels; **Rumsey** 2012 10th International Conference on Oral and Maxillofacial Surgery, China; **Hewlett** 2012 OMERACT, USA; **Killard,** ESEAC 2012, Slovenia. **Killard** also leads the Organic Electronics Association roadmap on Integrated Smart Systems.

A number of staff are involved in peer review roles for a wide range of journals and of particular note are those with editorship responsibilities: **Ladomery** (*International Journal of Molecular Epidemiology and Genetics*); **McCalley** (*Journal of Chromatography*); **Ratcliffe** (*Journal of Breath Research, Chemosensors*); **Conway** (*International Journal of Molecular Epidemiology and Genetics*); **Rhodes** (*Frontiers in Cancer Endocrinology*); **Evans** (*Critical Public Health* 2008-2010); **Rumsey** (*Body Image* 2008-2009); **Gray R** (*Schizophrenia*); **Albarran** (*Nursing in Critical Care*); **Towner** (*BMC Public Health*); **Moule** (*Nurse Education Today*); **Gray S** (*Journal of Public Health*); **Hewlett** (*Arthritis Care and Research*) and **Deave** (*Community Practitioners*).

6. *Fellowships and Personal Award:* The Unit has been successful in securing a number of prestigious externally funded fellowships in recognition of contribution to and standing in the field. In addition to those of **Walsh** (Arthritis Research UK, five-year fellowship) and **Dures** (two-year, Leverhulme Fellowship), there are two NIHR five year fellowships awarded to staff with a clinical practice role (**McCabe** and **Wren).** In addition, **Lewis** holds an NIHR Postdoctoral Clinical Lectureship. **Sanderson** has a two-year post-doctoral fellowship from MRC/ESRC and **Rumsey** received Vocational Training Charitable Trust funding of £550K to support two Research Fellows (2008-2013). **Varadi** mentored an EU supported Marie Curie Fellow (2008-2010).

Staff achievement has been recognised through prestigious personal awards. **Salisbury** was winner of a SEED Award 2008, an international initiative backed by the UN, to work with researchers in Delhi to develop antibacterial products to help prevent MRSA, whilst **McCalley** was winner of the 2008 Silver Jubilee Medal, awarded by the Chromatographic Society for internationally recognised work on the separation of compounds of biomedical significance and ethical pharmaceuticals and for becoming one of the most cited British authors in the past 10 years. **Rumsey** won a British Psychological Society, Division of Health Psychology Award for outstanding contribution to Health Psychology in 2012. **Benger** was joint winner of a Silver IDEA in the Research Category, 2012 International Design Excellence Awards for ambulance design. **Walsh** received a British Health Professionals on Rheumatology Best Audit Prize in 2011 for a practice based audit of knee osteoarthritis. Finally, fellowships are held by three staff. **Rhodes** is a Fellow of the Institute of Biomedical Sciences. **Hewlett** is Fellow of the Royal College of Nursing, nominated by nursing colleagues as only one of 6 elected in 2011 and **Roulstone** is a Fellow of the Royal College of Speech and Language Therapists and an Honorary Doctor of Health at Manchester Metropolitan University (2013).