Institution: University of Manchester

Unit of Assessment: 3

a. Overview [*Note: Returned staff are marked in bold (see REF2 for related outputs). Our 12 Impact Case Studies are identified as ICS-01 to ICS-12 italicised (see REF3a and REF3b to identify case studies). Short journal references are given for selected outputs*.]

This return comprises 112.6FTE staff from four "Health Schools" at the University of Manchester (UoM): (1) the Allied Health Professions (AHP) group in the School of Psychological Sciences (SPS) (9.7FTE), (2) School of Dentistry (SofD) (17.9FTE), (3) School of Nursing, Midwifery and Social Work (SNMSW) (53FTE), and (4) Manchester Pharmacy School (MPS) (32FTE).

The Schools: All four Schools have relocated to new/refurbished accommodation within 350 metres of each other since late 2007, and share research administration and infrastructure.

Allied Health Professions. Research focuses on basic science and clinical applications related to:

- Function of the normal and impaired auditory system
- Diagnosis and management of hearing disorders
- Speech and language disorders
- Aphasia and stroke

Dentistry. Research is organised in two broad themes:

- Craniofacial genetics and developmental biology, stem cells and cancer, and biomaterials
- Health policy, population health, health services research and clinical practice.

Nursing. Research focuses on clinical applications (including patient experience), population health and policy, and is organised into five groups, each with programmatic subthemes:

- Mental Health
- Cancer, Supportive and Palliative Care
- Long-term Conditions
- Population Health and Social Care
- Personal Social Services Research Unit (PSSRU)

Pharmacy. Research focuses on:

- Drug target identification and validation; development of molecular therapeutics; drug synthesis and associated biochemical and molecular pharmacology; development of nano-structures for targeted delivery, their toxicology and use in imaging and therapeutics; biofilms and disinfection; prediction of human drug metabolism and pharmacokinetics; and efficacy testing of novel mental health therapies.
- Pharmacy workforce behaviour; pharmaco-epidemiology and drug safety; prescribing and patient safety.

The REF period has seen a dramatic increase in UoA3 research activity. Our total grant spend has increased to **£42.7m**, thus UoA3 annual research spend climbed from £5.7m/year in RAE period 2001-7 to £8.5m/year in REF period 2008-13. Average annual research grant award value has more than doubled (£6.6m/year in 2001-7; £14.6m/year in 2008-13), with total grant awards of **£72m** (2008-2013). Some 43% of our grant income since 2008 is interdisciplinary across the Faculty of Medicine and Human Sciences (FMHS), but there are also significant collaborations across the University (Faculties of Life Sciences, Humanities, and Engineering & Physical Sciences), with the NHS (we have **£24m** of NIHR grants that run through Trusts), with universities (we have research collaborations with more than 150 universities in UK and internationally), with industry and commerce, and with charities and non-governmental organisations (NGOs). Since 2007/8, all four Schools have benefitted from major refurbishment of existing facilities and/or moved into new buildings. Since 2008 we have recruited 38 new research active academic staff (10 professors) and also there have been 38 research active academic promotions.

To represent the strength of our research, we have selected 428 outputs. These are from more than 2200 peer-reviewed papers published by returned staff in the REF period, of which 27% are in the top decile of subject-specific citation scores. High quality journals with multiple publications include (number of papers); *BMJ* (18), *Nature* series (11) *Cochrane Reviews* (105), *J Dent* (19), *Dent Mater* (59), *J Assoc Res Otolaryngol* (7), *Int J Nurs Stud* (44), *J Adv Nurs* (16), *B J Clin Pharmaco* (8), *Drug Metab Dispos* (29). We have selected 12 Impact Case Studies to demonstrate

the impact of our work nationally and internationally. Our staff provide research leadership and service to the wider community, revealed by: some 150 editors or editorial board memberships, more than 50 funding committee memberships and more than 150 government, NHS, regulatory, professional and NGO advisory committee memberships. During the REF period UoA3 staff gave more than 1100 expenses paid invited presentations. Amongst our many prizes and accolades, three staff were honoured by Her Majesty The Queen for contributions to science [**Noyce**, CBE; **Lavender**, DBE; **Cullum**, DBE].

UoA3 research focuses on (i) policy and population health oriented health services research, (ii) clinical research, and (iii) basic science laboratory and methodological research. Much of this research is undertaken through partnerships with NHS Trusts in Greater Manchester, through the Manchester Academic Health Science Centre (MAHSC) and with colleagues in Research Institutes across FMHS and the University (structures described more fully below). We have made major contributions to our respective disciplines since 2008 including:

Policy and population health

- We demonstrated by RCT that there is no evidence for effectiveness of school dental screening, which resulted in a change of Department of Health (DH) policy and cessation of the national screening programme [**Tickle**, **Worthington**; *ICS-10*].
- We revealed significant barriers to returning to work amongst cancer survivors because of attitudes of employers and health care professionals [**Luker**; *ICS-03*].
- We identified shortcomings of personal budgets as direct payment approach for older people [**Challis**; *ICS-02*].
- We demonstrated that prescribing errors were caused largely by stressful environments and unfamiliar systems, resulting in changes in General Medical Council prescribing skills training requirements and implementation of a national in-patient chart [**Ashcroft**, **Tully**; *ICS-06*].
- We identified activities which can be safely undertaken independently by pharmacy technicians and those that require pharmacist involvement [**Schafheutle**, **Willis**, **Noyce**].

Clinical practice

- We determined by RCT the clinical and cost effectiveness of communication therapy following stroke [**Hesketh**, **Young**].
- We demonstrated by systematic review that antibiotic prophylaxis against bacterial endocarditis for at risk patients undergoing invasive dental procedures is unwarranted, which resulted in new NICE guidelines [**Worthington**; *ICS-07*].
- We showed that Cognitive Behaviour Therapy delivered by telephone has medium to large effects on clinical and work outcomes, and is a cost effective intervention for people with chronic pain [**Bee**, **Lovell**; *ICS-09*].
- We undertook the first RCT in general dental practice of single-visit scale and polish, and could find no evidence that this treatment improves gingival health [**Tickle**].
- We demonstrated by RCT that during oral capecitabine treatment for colo-rectal or breast cancer, a symptom-based, nurse-led home care intervention programme is more effective than normal care [**Molassiotis**, **Luker**, **Todd**; *ICS-03*].
- We developed and, in RCT, demonstrated efficacy, acceptability and cost-effectiveness of lay-led approach to asthma self-management education [**Caress**].
- We demonstrated that anti-tumour necrosis factor (anti-TNF) therapies are effective in the management of psoriatic arthritis with no added risk of serious adverse events compared with conventional disease-modifying anti-rheumatic drugs [**Ashcroft**].

Underpinning basic science and methodology

- We provided the first evidence for subcortical auditory plasticity in response to short-term pitch training [**Plack**].
- We determined the trajectories of key aspects of functioning of individuals with specific language impairment from childhood to adolescence [**Conti-Ramsden**].
- We reported that p53-dependent apoptosis is the mechanism that generates the craniofacial anomalies observed in Treacher Collins syndrome [**Dixon M**, **Dixon J**].
- We developed methods for palliative and end of life research (NIHR/MRC Methodology Research Programme) and developed a novel prognosticator [**Grande**, **Todd**; *ICS-03*].
- We developed a new approach to qualitative research, centre stage diagramming, a collaborative and co-constructivist approach to methodological inquiry [**Keady**].

- We demonstrated synergy between hypoxia agents and radiotherapy in cancer treatment by using pre-clinical PET imaging [**Williams**].
- We developed strategies for human pharmacokinetic prediction based on in vitro pre-clinical methodologies, subsequently adopted by pharmaceutical industry and drug regulatory authorities [**Galetin**, **Hallifax**, **Houston**; *ICS-11*].
- We demonstrated that adding systemic immunotherapy (TLR7 agonist) to radiotherapy treatment of cancer was curative; which is not obtained when either is used alone [**Stratford**].
- We contributed to development of asenapine (designer/developer Organon; now approved for bipolar disorder and schizophrenia). The Technology Strategy Board has funded an evaluation of a first-in-class potassium channel modulator in schizophrenia [**Neill**, **Harte**].

Major publications since 2008 include (maximum of two per discipline due to space constraints):

Allied Health Professions: (1) *BMJ 2012;345:e4407* demonstrated the effectiveness of enhanced communication therapy after stroke and (2) *Cereb. Cortex 2009;19:576-85* identified multiple pitch processing sites in the human cortex.

Dentistry: (1) *Cochrane Database of Systematic Reviews 2010, CD007868* revealed that caries prevention by fluoride toothpastes for children is only significant for fluoride concentrations ≥1000ppm and (2) *Nature Genetics 2011;43:20–22* identified two additional genes involved in Treacher Collins syndrome, confirmed its genetic heterogeneity and supported the ribosomopathy hypothesis.

Nursing: (1) *BMJ 2013;347:f4913* demonstrated the clinical effectiveness (persistent positive effects) of collaborative care compared to usual treatment in the management of patients with moderate to severe depression and (2) *NEnglJMed 2008;359:677-87* showed that for stable angina patients, both percutaneous coronary intervention (PCI) with optimal medical therapy (OMT), and OMT alone significantly improve health status at follow-up, although greater benefit from PCI was found in patients with more severe and more frequent angina.

Pharmacy: (1) *JClinEndocMetab 2011;96:E1934-43* identified the prominent role of Phosphoinositide 3-kinase (PI3K) in metastatic thyroid carcinoma cells and that GDC-0941 significantly inhibits the metastatic phenotype, supporting clinical development of PI3K inhibition and (2) *DrugMetabDispos 2010;38:1147-58* identified intestinal availability using Q_{Gut} model for drugs with different characteristics, drugs with low intestinal extraction were well predicted, but for those with high intestinal extraction prediction was less accurate.

b. Research strategy

In RAE2008, AHPs, Dentistry, Nursing, and Pharmacy were returned under separate UoAs10-13. During 2008-09 we undertook a thorough review of research performance by looking at individuals and aggregating results up to group, School, FMHS and University. This approach, along with our strong RAE2008 results, allowed us to identify strengths and areas requiring development or disinvestment, thus informing the basis of a strategy for UoA3 Schools, as part of the *Manchester 2020* plan. The strategy sets a series of ambitious five-year goals. Progress is reviewed in annual performance reviews using key performance indicators (KPIs) based on input and output metrics, with 2015 as an interim milestone and 2020 as our long-term target. This strategy was developed by, and is implemented through, regular meetings of the Directors of Research from the Health Schools. Our strategy permits us to focus on strengths, while maintaining breadth. Central to our strategy is the prioritisation of Population Health research, identification of evidence and implementation gaps, and promotion of interdisciplinary working. We have taken steps to stimulate research by: (a) supporting research-focused academic staff by introducing workload management for teaching/research allocation and strengthening staff performance review and development; (b) improving grant capture by provision of seed corn funding and Public and Patient Involvement (PPI) support schemes, and introduction of mandatory internal peer review before submission of grant applications; (c) providing high-quality administrative infrastructure for research management and governance functions; and (d) introducing publication policies to target high-quality journals and support open access publication. Section d reveals our success in achieving our goals.

UoA3 within University and Faculty Structures

The **University of Manchester** is the largest single-site university in UK, with an annual income of **£827m**. UoM employs over 10,500 staff and has 41,000 students (11,000 postgraduates). Our strategic plan, *Manchester 2020,* permeates the organisation to drive strategic investment at

Faculty, School and Research Group level. Research commercialisation includes 1600 invention disclosures, 17 new companies, and has attracted **£173m** in third-party investment.

The **Faculty of Medical and Human Sciences** is one of four UoM Faculties. FMHS is among the largest in the UK, with some 570 academic staff, 670 full-time research staff, 6000 undergraduates, and 2300 postgraduate students. FMHS has an annual income of **£210m**, and research spend of **£79.6m** in 2013. The Dean, Ian Jacobs, appointed in 2011 has led a major reorganisation of FMHS. The new FMHS structure comprises a matrix of five professional Schools (four UoA3 Health Schools plus Medicine) and six Faculty Research Institutes (Brain, Behaviour and Mental Health; Cancer Sciences; Cardiovascular Sciences; Human Development; Inflammation and Repair; Population Health). UoA3 Health Schools played a major role in shaping this new structure. Our research, whilst based administratively in the Schools, permeates all of the Institutes. All research staff are affiliated to Institutes and our staff have major leadership roles in many parts of the structure, as well as leading projects and programmes within the Institutes. The new FMHS structure and research strategy has enhanced the research environment for UoA3 Schools and provides an environment rich with opportunity for interdisciplinary research.

Manchester Academic Health Science Centre established in 2009, is central to the integration of translational research into healthcare delivery across the conurbation. MAHSC comprises UoM and six NHS Trusts [Central Manchester University Hospitals NHS Foundation Trust (CMFT), Salford Royal NHS Foundation Trust (SRFT), Christie NHS Foundation Trust (Christie), University Hospital of South Manchester NHS Foundation Trust (UHSM), Manchester Mental Health and Social Care Trust (MMHSCT), and Salford Clinical Commissioning Group]. The MAHSC structure reflects priority areas for investment and development, so that each of the MAHSC "domains", led by a Trust CEO, mirrors a FMHS Institute. MAHSC is one of five DH designated AHSCs in the UK; the only one outside the South of England. MAHSC provides an infrastructure which benefits UoA3 staff in their research with the component NHS Trusts, simplifying access and collaboration with clinical colleagues. UoA3 is fully engaged with the recently established MAHSC Clinical Trials Unit (MCTU); a recent NIHR-funded dental RCT is one of the first delivered via MCTU. Part of the agreement between UoM and MAHSC Trusts is that NIHR funding is managed by NHS Trusts, while RCUK funding is managed by UoM. One net effect of this is that **£24m** of UoA3 NIHR grants do not appear in REF4. In 2013 the Greater Manchester Academic Health Science Network (AHSN) was established. AHSN will roll-out MAHSC's eHealth informatics platform so as to reach a population of 3 million over the next 3-5 years, providing a unique platform for planned Population Health research developments.

Greater Manchester Collaboration for Leadership in Applied Health Research and Care (**CLAHRC**) UoA3 staff, alongside colleagues in UoA2, play major roles in the five-year, **£10m** NIHR contract (with £10m matched NHS partner funding) in running the CLAHRC partnership of 20 NHS Trusts and UoM. CLAHRC carries out applied research and implements it to benefit patients. CLAHRC focuses on patients with vascular disease (especially stroke), heart disease, kidney disease, diabetes and long-term conditions. Funding of a further £10m from NIHR with matching resources/funding from NHS Trusts for CLARHC from 2014 has been secured. This will permit us to develop the programme strategically in strength areas (e.g. end of life and wound care) to cover patient-centred care, primary care, and community services.

UoA3 Strategy 2008-2020

Core to all UoA3 disciplines is a commitment to sustaining world-leading research on a broad front. Over the REF period we have succeeded in this ambition and our strategy, supported by the infrastructure developed in Manchester over the last five years, will maintain this approach over the coming years. This strategy will allow us to be responsive to changes in the funding and political landscape, as well as ensuring we maintain our strategic influence within UoM. All four Schools have developed strategies, nested within FMHS and the overarching *Manchester 2020* strategy, which set specific KPIs at School level with 2015 milestones. Key elements of our strategy include:

1. **Funding:** We will increase our research funding capture (with specific sub-goals of increasing diversification, high-quality competitive peer reviewed funding, and more programmatic funding) (see section d). To achieve this we introduced a system of internal peer review. A dedicated Faculty Research Deanery office provides research intelligence to target funding strategically. We have pooled research support management to increase critical mass and provide a

seamless service. We will continue investment in infrastructure to provide state-of-the-art facilities to support our research, both in terms of buildings, laboratory space and equipment, and in terms of administrative infrastructures to facilitate research management. We will manage performance at individual, group and School levels, with indicative income and output targets on an annual cycle. We will proactively encourage and support diversification of funding from high esteem sources by identifying funding streams and opportunities.

2. **Staff development**: We continue to identify and recruit talented researchers (e.g. **Burden**, **Buti**, **Hopkins**, **Lewis**, **Thiruvenkatachari**, **Wu**), nurture and support them to become research leaders (e.g. **Pretty**, **Williams**), as well as recruit existing star researchers at senior lecturer (e.g. **Dumville**, **Hunter**) and professorial level (e.g. **Cullum**, **Neill**, **Plack**). We have established a "Fellowship Academy" to identify and support fellowship applicants and then nurture successful fellows throughout the process (e.g. **Stanmore**, **Aggarwal**, **Brocklehurst**). We use our staff Performance Enhancement Review scheme to guide and reward research achievements for quality, income and impact. To create nurturing and stimulating intellectual environments, we will further develop staff mentoring and training schemes to provide the skills required for career progression. In line with our commitment to Athena SWAN, we promote equality and act to enhance the position of women in the disciplines of science, technology, engineering, mathematics and medicine. The University, Faculty and all four Health Schools have achieved Bronze Athena SWAN awards and are aiming for Silver awards during 2015.
3. **Collaboration and prioritisation**: We will continue to improve links with NHS clinicians through MAHSC, CLAHRC and AHSN, and with local government policy makers, DH and internationally. We will strengthen our collaborations with international world-class research leaders and institutions (e.g. Harvard). We will increase collaboration with industry (e.g. Colgate, Roche, Shire, Siemens, Simcyp, Takeda) and third sector partners (e.g. AgeUK). We will continue to review and prioritise areas for development and strengthen interdisciplinary working.
4. **Impact**: We will increase the quantity and quality of our research outputs, as measured by citation analysis, through refinement of publication and dissemination policies. We will target top quartile journals and implement open access publication policies so as to maximise the reach of our research. We will focus on research aimed at improving patient and population health and wellbeing, providing value to NHS and commercial partners. We will continue to support the implementation of our research through MAHSC, CLAHRC and AHSN. We will invest in methods to demonstrate impact has occurred.

Achievements during REF period. [*Evidence is provided in REF2 outputs and Impact Case Studies. We indicate selected grants or total income during period. In line with MAHSC agreement, many NIHR grants run through NHS Trusts, so not all monies reported appear in REF4*.]

Allied Health Professions

Clinical Research: Within the Audiology and Deafness group, **Munro** developed and validated the approach to measuring the acoustic transfer function of the external ear in infants. Collaboration with international hearing aid industries (Phonak, Siemens) has ensured that these procedures are implemented in routine clinical practice in UK and across the world. **McKay** has worked closely with Advanced Bionics and Cochlear Ltd (MRC £565k) and delivered: a new design of an auditory midbrain implant; significant progress towards an automatic programming method; and an improved way of combining a hearing aid with a cochlear implant. **Kluk-de Kort** and **Plack** (MRC £548k) are developing an objective audiological test-battery, based on discoveries made by the group on the use of novel electrophysiological methods for measuring auditory tuning curves and cochlear "dead regions" [**Kluk-de Kort**]. A new MRC Programme Grant (£1.2m, **Plack, Hopkins**, **Munro**, **Kluk-de Kort**) uses psychophysical and electrophysiological techniques to investigate the prevalence and impact of "hidden" noise-induced hearing loss, undetectable by conventional audiometry. Within the Language Development and Disorders group, **Adams** developed an intervention programme for children with communication difficulties which is efficacious for higher order communication outcomes. **Hesketh** and **Young** (SNMSW) (HTA, DH, Stroke Association £1.5m) provided key evidence of effectiveness of enhanced communication therapy for aphasia and dysarthria after stroke.

Basic Science: The Audiology and Deafness group have greatly expanded work in auditory plasticity including plasticity from auditory deprivation and hearing aid use [**Munro**] (MRC £310k). The work demonstrated that real-life perceptual benefits of plasticity are small in adults when

prescribed digital hearing aids; a finding of economic and practical significance as clinicians no longer wait for long periods of 'acclimatisation' before measuring clinical outcomes and clinical trials can be conducted over shorter time periods. We made significant breakthroughs in the understanding of the neural basis of pitch perception [**Plack**] (MRC £320k), and of the effects of age and hearing loss on neural encoding of temporal fine structure of sounds [**Hopkins**]. In the Language Development and Disorders group we focus on specific language impairment (SLI) (ESRC £1.3m). Using novel developmental trajectory models, we identified deceleration in growth of nonverbal skills in one in three children with SLI and increasing developmental vulnerability for social difficulties from childhood to adolescence**.** We characterised the risk of clinical emotional health symptoms in adolescents with SLI, and generated the first evidence of improvement in national educational qualification standards for children with SLI at the end of compulsory education [**Conti-Ramsden**].

Dentistry

Population Health and Policy: We have developed our capabilities in Health Sciences to produce research which benefits clinical services and patient care (total NIHR grants >£5m). We established the Healing Foundation-funded (£2.3m) Cleft and Craniofacial Clinical Research Centre and, in partnership with CMFT, host the National Clinical Trials Unit for Cleft, which services all UK cleft research. Colgate Palmolive provides £1m over 5 years for the Dental Health Unit. The Cochrane Oral Health Group's (COHG) recurrent funding is augmented by £211k committed by the COHG Global Alliance. **Glenny** conducted a series of systematic reviews on community-based interventions (US Centers for Disease Control and Prevention $886k). Systematic reviews are the bedrock of an evidence-based approach to policy and practice. Since 2008 we increased by >20% the number of COHG reviews, and are ranked 2nd for output productivity out of all 23 UK-based Cochrane groups. Our Cochrane reviews influence population health and policy. Our fissure sealant review provided strong evidence of effectiveness leading to guidance for school-based fissure sealant delivery programmes [**Walsh**, **Worthington**]. Other reviews led to guidelines on mouth care for cancer patients, which have been implemented in the majority of the UK children's haematology/oncology centres [**Worthington**, **Clarkson**, **Glenny**]. Our review of different concentrations of fluoride toothpaste demonstrated low concentration toothpastes were ineffective in preventing caries, with the result that major manufactures withdrew these products. The review also informed the DH "*Delivering Better Oral Health*" evidence-based toolkit distributed to all dental practices in England [**Walsh**, **Worthington**, **Glenny**]. Our public health RCT of fluoride varnish cast doubt on effectiveness for caries prevention in school settings [**Tickle**, **Walsh**, **Worthington**]. We developed new technologies for population surveillance of fluorosis, adopted by Public Health England and US CDC, and incorporated into the US National Health and Nutrition Examination Surveys [**Pretty**]. Our work on incentives (**Tickle, Aggarwal**) demonstrated that the introduction of the 2006 dental contract resulted in abrupt, large reductions (~50%) for key treatments (crowns, endodontic therapy, radiographs) and a concomitant rise in the number of extractions.

Clinical Research: Based on **Glenny**, **Worthington** and colleagues' Cochrane review, NICE issued guidance resulting in cessation of the use of prophylactic antibiotics for patients with heart defects receiving dental treatments [*ICS-07*]. **Horner** led the EU SEDENTX (EC £2.5m) programme which produced evidence based guidelines on use of Cone Beam Computed Tomography in dental and maxillofacial radiology. **O'Brien**, **Walsh** and **Thiruvenkatachari** undertook a series of RCTs which inform orthodontic treatment of Class II malocclusion in adolescents.

Basic Science: We focus on craniofacial biology, stem cells and biomaterials, with £3.7m funding from MRC, BBSCR, EPSRC, Wellcome, plus membership of 2 EPSRC consortia worth £3.6m. We reported that p53-dependent apoptosis underlies Treacher Collins syndrome [**Dixon M**, **Dixon J**]. Using exome sequencing, we identified FAM20A mutations as a cause of *amelogenesis imperfecta* [**Dixon M**, **Dixon J**]. We generated a genomic map of Hox protein occupancy in the brachial arches [**Bobola**, **Ward**]. We found that lack of E-Cadherin results in LIF-Independent ES cell self-renewal [**Ward**, **Bobola**]. We computed bulk phase material properties of dental composites via two-phase Finite Element models and determined effects on polymerisation stress [**Watts**]. We characterised clinically pure Titanium surfaces after electro discharge machining [**Silikas**].

Nursing

Population Health and Policy: Social Care and Population Health. The *Active Ageing programme* has consolidated its international reputation for falls research. We demonstrated excess falls risk in rheumatoid arthritis; how personal, ethnic and socio-demographic factors drive use of falls services; further developed the FES-I fear of falling instrument; and tested novel interventions for people with visual impairments (NIHR £499k) [**Horne**, **Speed**, **Stanmore**, **Todd**, *ICS-05*]. We have developed gerontechnology research with two major EC grants, demonstrating the value of mobile phone, ICT and gaming technologies in falls detection and prevention. We collaborated with the Photon Science Institute and School of Engineering to develop novel fibre-optics for gait and physiological function measurement ("iMagiMat") (EPSRC £79k, EC €4.5m). *Midwifery and Women's Health* focus on implementation of interventions to reduce mortality and play leading roles in the Cochrane pregnancy and childbirth review group, as well as produce research exploring experiences of pregnancy [**Lavender**, **Furber**, **Mills**, **Bedwell**] (Tommy's £699k). With industrial partners (Johnson & Johnson, £572k) our RCT demonstrated product safety and that "natural" massage oil can be detrimental to neonates' skin [**Lavender**, *ICS-12*]. *Social Research with Deaf People* (NIHR, RCUK and charity funding, £1.4m) are a world-leading sign bilingual research group focussing on health and social care. We lead on the validation for the national Improving Access to Psychological Therapies programme of standard psychological assessments in BSL and wrote the first methodological book on social research with d/Deaf people [**Young**]. Personal Social Services Research Unit (PSSRU) is a foundation member of NIHR School for Social Care Research. PSSRU has undertaken major policy oriented work on single and self-assessment in care of older people (DH £1.2m) [**Challis**, **Clarkson**, **Hughes**, **Tucker**]. PSSRU's studies of care coordination and case management in long-term care (DH & NIHR £1.95m) have been particularly influential in guiding policy; the national development of personal budgets was evaluated by PSSRU shaping the implementation process. [*ICS-02*]. We examined old age mental health care (NIHR £1.2m) shaping health and social care policy. A new large programme (NIHR £2.0m) is examining effectiveness of different approaches to community support of people with dementia.

Clinical Research: Mental Health Our *Developing and Evaluating Complex Interventions Theme* focuses on innovative psychological interventions for mental health problems, (MRC £2.3m; NIHR, £14.2m in project and programme grants) and has been at the cutting edge of the national policy agenda to increase access to psychological therapies. The team have made significant contributions to the areas of Guided Self Help and collaborative care for common mental health problems and long-term conditions, determining acceptability of interventions and the use of remote methods in delivery of Cognitive Behaviour Therapy [**Archer**, **Baker**, **Bee**, **Kendal**, **Lovell**; *ICS-09*]. The *Dementia and Aging Research Theme* has developed a portfolio of funded person centred education and intervention studies in dementia care [**Keady**] (HTA £206k) and in late 2013 was awarded a £5m ESRC/NIHR dementia research programme. Cancer, Supportive and Palliative Care: **Grande**, **Todd** and **Molassiotis** played major roles in the National Cancer Research Institute (NCRI) Cancer Experiences Collaborative (CECo) (total £1.8m) leading two of the three research programmes as well as capacity building. *Family carers research theme*: We have taken a leading international role in setting the agenda for carer research, developed a tool for assessing carer needs, and interventions to help staff intervene and equip carers to provide support at home [**Grande**, **Luker**], (NIHR £495k; Dimbleby Cancer Care £417k) [*ICS-03*]. *Timely and equitable access to care and treatment theme*: We demonstrated that age still drives inequitable access to cancer treatment (NIHR programme £1.45m, NIHR and Breast Cancer Campaign £470k) and identified important drivers in decision making in clinics, "post-code" inequity in out of hours access, and district nurses' role conflicts in psychological and physical care [**Degner**, **Lavelle**, **Griffiths**, **Todd**; *ICS-03*]. *Management of complex symptoms and psychological wellbeing theme*: We demonstrated effectiveness of acupuncture in fatigue management (Breakthrough Breast Cancer £314k), that chemotherapy can be managed effectively at home by nurses, that preoperative nutrition supplementation reduces post-operative complications and that a multi-disciplinary breathlessness intervention is cost-effective for patients with advanced cancer [**Burden**, **Degner**, **Farquhar**, **Luker**, **Molassiotis**, **Tishelman**, **Todd** [*ICS-03*]. Long-term Conditions *Children and Young People:* **Callery** played an important role in the development of the NIHR GM Medicines for Children Network and we identified life enhancing approaches to management of a broad range of serious diseases (DH £343k, SDO £220k) [**Callery**, **Kirk**, **Milnes**,

Swallow]. *Adults:* Studies on a range of long-term conditions in adults have resulted in improved outcomes for stroke rehabilitation [**Tyson**]; demonstrated effectiveness of lay-led approaches to asthma self-management [**Caress**]; developed assessments for a number of respiratory diseases [**Yorke**]; revealed effectiveness of PCI, and improved physical activity adherence in heart failure [**Deaton**, **Dunbar**]. **Cullum** and **Dumville** demonstrated that larval therapy quickly debrides venous leg ulcers without speeding healing, and that two layer compression stockings reduce recurrence and are more cost-effective than 4 layer bandages for venous ulcer healing. Our musculoskeletal studies demonstrated; frail elderly men benefit from testosterone treatment [**Oldham**] and the lack of effectiveness in prioritisation of patients awaiting joint surgery [**McHugh**]. *Basic Science and Methodology:* Working closely with the Manchester Maternal and Fetal Health Research Centre (UoA1) our *Midwifery Group* contributed to understanding of placental oxygen and nutrient transport [**Mills**]. In our *Methodology Theme,* **Todd** co-led the MORECare project developing end-of-life care research methods (NIHR/MRC £399k) and developed the PiPS prognosticator, specifically identified by HTA for future development funding. We contributed to falls research methodology revealing how lack of standardisation explains inconsistent findings [**McHugh**], and creating the taxonomy used in a meta-analysis revealing exercise reduces injuries. We published the first mixed treatment meta-analysis in wound care [**Dumville**, **Cullum**].

Pharmacy

Population Health and Policy, and Clinical Research: Research on pharmacy workforce employment issues has a long-standing track-record of attracting funding and successful multi-disciplinary collaborations in primary care [**Hassell**, **Tickle**, **Sibbald** (UoA2), **Sutton** (UoA2), **Jacobs**, **Schafheutle**; CfWI £420k, NIHR HSDR £400k]. Joint research with Dentistry demonstrated how changes to national contracts can incentivise professional behaviours which do not accord with policy intentions [**Hassell**, **Tickle**, **Ashcroft**; SDO £320k]. Work on workforce dynamics, attrition, and job satisfaction [**Hassell**, **Seston**, *ICS-01*] is informing policy for NHS: Health Education England and HEFCE on the future of pharmacy student numbers and workforce planning. **Willis's** studies provide new insights into pharmacists' career development and the development of safe practitioners. Our policy work on risk in community pharmacy [**Ashcroft**, **Phipps**, **Schafheutle**] and revalidation [**Noyce**, **Schafheutle**, *ICS-06*] provided decisive evidence to the General Pharmaceutical Council on future professional regulation. Health science and clinical research combine in **Tully**, **Ashcroft** and **Lewis's** multidisciplinary work on prescription and medication errors, pharmaco-epidemiology and drug safety [*ICS-06*]. **Ashcroft** leads the multi-disciplinary Medication Safety work in the NIHR Greater Manchester Primary Care Patient Safety Translational Research Centre (£6.2m). **Tully** leads Patient and Public Involvement (PPI) for the Health eResearch Centre (HeRC) (MRC-led consortium £4.5m).

Basic Science and Translational Research: **Stratford** and **Williams** (MRC, cancer charities, EU and industry funding £2.2m) with Manchester Cancer Research Centre (MCRC), have conducted successful early clinical trials of drugs to improve the outcome of radiotherapy [*ICS-08*] and PET imaging to aid diagnosis and assess response (**Williams** EPSRC/CR-UK Imaging Centre, £4.5m). They will build on their expertise in DNA damage responses and cellular redox (with **Demonacos**) to identify new molecular (drug) targets to enhance tumour responses to radiation. **McBain** has maintained the momentum of the microbiology research group (MRC, industry funding £1.6m), which provides a good example of collaboration within UoA3 (**Pretty,** Dentistry). Colgate funding (£500k) is used to probe biofilm/biocide resistance and linkage to oral hygiene. The appointments of **Marshall** (women's health), **Neill**, **Harte** (psycho-neuropharmacology), and **Nicolaou** (lipodomics), enhance MPS's contribution to MAHSC and UoM Research Institutes. **Neill** and **Harte** (with two FHMS Research Institutes) have secured £1.8m Technology Strategy Board funding for an industrial collaboration with Autifony to develop therapies in schizophrenia. **Bryce**, **Freeman** and **Stratford** link structural biology with computational chemistry for the rational design and synthesis of novel small molecules with potential application in cancer, infection and neurological diseases. This is complementary to **Bichenkova** who is developing molecular scissors to selectively target RNA sequences important in cancer and infection. CAPKR maintains its position at the international forefront of predictive pharmacokinetics (**Aarons, Galetin, Houston**; £2.5m), has increased its effectiveness by joint appointment with Simcyp of **Rostami-Hodjegan**, and has become a key leader for the drug development process and its impact on drug regulation policy [**Rostami-Hodjegan**, **Galetin**; *ICS-11*]. **Aarons** and **Stratford** partnered with AstraZeneca (£1.5m, from 2013) to establish a Modelling and Simulation Centre to link CAPKR

and the Clinical Trials Unit at Christie Hospital. **Tirelli** (returned in UoA13) was appointed to develop nanomaterials as delivery systems and recent appointments include **Kostarelos, Hunter** and **Bussy** to develop carbon nanotubes, graphene and other nano-materials as delivery systems for imaging and therapeutics, complementing our research on the transport and stability of biologics (**Pluen**).

c. People, including:

i. Staffing strategy and staff development

In the 2013 UoM staff survey, 96% of our academic and research staff indicated that UoM is a good place to work, 96% were proud to work here, and 97% agreed with the goal of producing world-leading research. These data support our staffing strategy, in terms of job satisfaction and sign-up to the cultural values of our research strategy.

Recruitment policy

All four disciplines follow a common recruitment strategy. We have recruited 38 research active academic staff in priority areas, 10 Professors (**Plack**, **Clarkson**, **Cullum**, **Dunbar**, **Lavender**, **Tyson**, **Kostarelos**, **Marshall**, **Neill**, **Nicholau**), 10 Senior Lecturers/Readers and 18 Lecturers. By providing a supportive environment to fulfil research aspirations, we have also developed academic staff from our own postgraduate and postdoctoral researchers (1/3 of our lecturer appointments were “internal”) and encouraged talented clinicians to become research active.

Academic staff development

We support junior staff to achieve their potential and see capacity building as a requirement across all career grades to ensure sustainability and succession. As part of annual Performance Enhancement reviews, staff agree personal research, teaching and management objectives. This approach ensures that workload balances can be maintained. Feedback against agreed objectives is provided using output/publications, grant income, and esteem indicators based on data collected as part of the FMHS annual Research Performance Exercise. New lecturers undertake the New Academic Programme, are allocated mentors, have reduced teaching loads to facilitate research start up, and are guided on how to gain tenure. All academic staff are supported to obtain external research funding and have access to the full range of staff development and training programmes within FMHS and UoM. Staff development funds, managed within Schools, assist conference attendance and specialist training. This approach creates a supportive and intellectually invigorating environment providing opportunities for interdisciplinary work. To promote inter-disciplinarity, FMHS runs regular interdisciplinary research seminars across Schools and Institutes, in which speakers from different disciplines approach a specific substantive issue highlighting how synergies are obtained through working together. It is indicative of the success of our approach that 12.6% (n=15) of this UoA3 return are Early Career Researchers, and that since 2008 we have made 38 promotions, 12 to Professor, 11 to Reader and 15 to Senior Lecturer.

Staff attend courses on leadership and mentorship to provide them with the skills to lead programmes of research and nurture other staff. Since 2008 nearly 1/3 (n=34) of UoA3 returned staff have been on such a course. A mentoring culture is supported through the award-winning Manchester Gold programme, which is available to all staff. Staff on this programme are matched to more experienced colleagues, who act as their career mentor over a fixed time period.

We believe research capacity building is vital to develop the next cadre of researchers and support as many people as possible to gain externally funded training. We provide support in writing grants and provide rigorous internal peer review, finance and governance support for all grant applications. We developed a fellowships pathway to assist staff and doctoral students to prepare competitive training applications from the earliest stage of the application process. Consequently, we have been successful in obtaining 39 fellowships for staff and post-docs since 2008. This function has been augmented by the creation of the Faculty Fellowships Academy providing infrastructure to support applications and post award mentoring.

Fixed-term research staff development

The University Staff Training and Development Unit provides a comprehensive range of training to fixed term and Early Career Researchers. To achieve the goals of the *Concordat to Support the Career Development of Researchers*, UoM developed a Concordat Implementation Plan which received the HR Excellence in Research Award from the European Commission. A comprehensive

guide to working in higher education, the "*An Academic Career*" website, was developed by UoM Careers Service and won the Times Higher Education (THE) 2011 Award for Outstanding Support for Early Career Researchers. UoM also received the 2011 Scopus Fostering Young Researchers Institutional Award. Our annual Research Staff Conference provides up-to-date information and networking opportunities to research staff across UoM. There is a biennial FMHS away-day and we organise a full range of training events for research staff. In 2009 FMHS's training manager was shortlisted for THE award for outstanding support for early career researchers and in 2011 awarded a distinguished achievement medal. Each School is proactive in researcher training, and organise flexible training and induction programmes. A handbook presents research strategy, structure and useful practical information for new starters as well as research governance policies and procedures, staff development and review, and laboratory and fieldwork safety. Our training programmes fulfil Concordat and Research Council skills training requirements and include:

- online training modules and dedicated intranet sites;
- careers service workshops and one-to-one advice on career planning;
- contracted in specialist methods training as needed;
- away-days focused on career development including grant and fellowship writing skills.

To enhance a sense of community Research Staff Fora are organised by elected research staff representatives in each School, who also represent research staff at School, FMHS and University levels. Through these fora, we provide generic training (e.g. presentation skills, writing for publication workshops), methods training tailored to researchers' needs and research governance update sessions. In addition to redeployment opportunities, at the end of fixed term contracts we offer 3 months full pay continuation and 3 months further support to assist staff to find employment.

We take Health and Safety very seriously, and as well as standard inductions provide health and safety training in all laboratory areas. For fieldwork staff we provide Suzy Lamplugh Trust training and have clear protocols for fieldwork using either 24/7 Lone Worker Technology (Peoplesafe) or mobile phone based protocols as appropriate.

The University is committed to the advancement of equality in employment and career development and equality monitoring and action planning is embedded into annual performance reviews. The University has been awarded the "Two Ticks" disability symbol, and is one of a small group of institutions that is part of the Equality Challenge Unit's Black and Minority Ethnic Systemic Change Pilot. As described on page 5 we are actively involved in the Athena SWAN Charter.

ii. Research students

We have amongst the biggest PhD programmes in the UK for UoA3 disciplines. Since 2007, **221** PhDs have been awarded, a rate of 44 per annum, up on our 2001-07 rate of 39 per annum. UoA3 research students are highly satisfied with supervision and courses; 86% scored very satisfied/satisfied in the 2013 PGR student survey, and first time pass rates exceed 80%. At REF census date there were 153 PhD students registered in UoA3. Since 2008 UoA3 has held 44 RCUK studentships (mostly MRC), 18 CASE awards; with RCUK DTG income valued at **£2.1m**. Amongst this group of students 5 year completion rate is 83% (4 year submission rate = 77%).

We recognise the vital importance of research students to the future of our disciplines, and building research capacity by providing the highest quality research training is central to our sustainability strategy. We provide an environment to support our best students to move through Masters to PhDs to post-doctoral and then academic posts. The FMHS Graduate School supports the recruitment and progression of postgraduates and provides training in communication, thesis writing, and career management skills. FMHS generic events promote interdisciplinary interaction between students. Each School provides profession-specific support, including personalised research training, with Directors of Postgraduate Education overseeing allocation of supervisors, examiners, etc. Our Graduate Society hosts public engagement activities and external speakers, enhancing networking opportunities. The Manchester Doctoral College provides governance and strategic oversight of PhD training at University level. Doctoral Training Centres (DTCs) have been established in diverse areas. DTCs aim to develop capacity in prioritised areas of skills shortages in which we have international repute. We co-host the collaborative North West ESRC DTC (Health and Wellbeing Pathway), and offer RCUK studentships from MRC, ESRC, BBSRC, and EPSRC across our disciplines. Our current RCUK Doctoral Training Grant (DTG) funding model is 3+1

years, permitting consolidation to facilitate publication and fellowship application. In this respect, DTG funding acts as 'bridging' to allow outstanding students to progress their careers.

We recruit PhD students from clinical professions, most of whom have spent time in clinical practice since graduation. It is important to meet the expectations and needs of these professionals, and enable them to maintain their clinical competence. Two approaches have proven particularly important.

(i) Highly competitive doctoral training fellowships are funded by NIHR, RCUK and AMRC charities, offering full salary PhD fellowships, while maintaining appropriate clinical practice. We have developed mentoring schemes (recently enhanced by the Fellowship Academy) to help us identify candidates, support them through the competitive application process and, once funded, provide them with bespoke supervision. Since 2008 we have hosted 31 such PhD fellows.

(ii) MAHSC Trusts are committed to research capacity building and release staff for part time PhD study. Some 25% of research students in UoA3 are undertaking part time degrees. We have developed flexible approaches to supervision to facilitate PhD completion for part time clinically-active students. Particularly successful features have been the development of online research methods courses and online supervision and progress monitoring techniques, allowing students to study at times which fit with clinical and other commitments.

UoA3 has developed MRes and MSc provision in areas as diverse as health and social care, community pharmacy public health services and advanced audiology. Our Masters programmes operate under an 'alliance' structure to support interdisciplinary training. Our MClinRes and MRes programmes (on which we have had 74 NIHR funded places since 2008) provide research training and a pathway into PhD programmes. We recruit internationally and some 33% of research students are non-EU. As part of our social responsibility programme we have provided fee and living expense support to talented students from countries in the developing world.

President's Doctoral Scholar Programme: Since 2012, these flagship and highly competitive awards have provided £2.5m over 4 years to secure exceptional PhD students, to whom an increased stipend and a bespoke set of development opportunities is offered. Currently UoA3 holds 9 of the President's 37 awards in FMHS.

Supervision and Support: Primary PhD supervision is provided by experienced supervisors in the cognate area of study. New supervisors must act as co-supervisor to completion prior to holding primary supervisory responsibility. Effective supervision forms the basis of our '*New Supervisor'* and refresher courses on supervisory policy, good practice in recruitment, managing student-supervisor relationships and supporting career development. PhD progress is monitored and supported through eProg, the UoM online system which maps students' progress, flags key assessment milestones and allows continual supervisory feedback. Students are integrated into the research culture of the Schools and encouraged to attend regular School, FMHS and Institute seminars. Each School has a number of postgraduate prizes, as well as PGR student of the year awards at School, Faculty and University level. There are a number of funds and bequests available to support travel, research expenses, and when required hardship.

Employability Support: The UoM Careers Service supports PhD career choices and was voted best in the country for three years running by the Association of Graduate Recruiters and Barker's Graduate National Media Audit.

d. Income, infrastructure and facilities

Income

There has been a 49% increase in annual research spend over period (see REF4b), with an upward trajectory rising from **£7.5m** in the year 2008-09 to **£9.5** in the year 2012-13.

Table 1 Research spend 2001-2007 (7 years) and 2008-2013 (5 years)

	Total	Mean annual spend
2008-2013	**£42.71m***	**£8.54m**
2001-2007**	£40.85m	£5.84m

*excludes Tirelli £3.8m returned in UoA13; **RAE2008 excludes newborn screening programme

In addition UoA3 staff are PIs or CIs on **£24m** of NIHR grants held in NHS Trusts under the agreement which allocate these grants to NHS partners rather than UoM (see section a: MAHSC)

and a further **£10m** in NHS contributions to the CLAHRC, co-managed by UoA3 and UoA2 staff, and renewed in 2013 for a further 5 years. Since 01/2008 UoA3 has been awarded **£73m** in research grants (based on percentage shares of UoA3 staff only).

TABLE 2 Grant awards 2001-2007 (7 years) and 2008-2013 (5 years)

	Total	Mean annual award value
2008-2013	£73m	£14.6m
2001-2007*	£46m	£6.6m

In RAE2008 we reported **£46m** of grants secured, a grant award rate of £6.6m/year (AHPs reported an additional £39m of research-led service development and implementation funding for newborn hearing screening, now directly managed by Public Health England). Our current total of **£73m** in grants awarded in this REF period reveals that we have more than doubled our grant capture rate to £14.6m/year compared to £6.6m/year previously. Much of this is yet to be spent, and thus UoA3 is well positioned for the future in terms of research income.

Infrastructure and facilities.
UoM has invested **£750m** in capital since 2004 to provide a 21st century research environment. A second phase of major investment of **£1bn** over the next ten years, part funded by a **£300m** public bond, includes relocating all of UoM onto the main campus and creating a new Biomedical Campus, including a new health centre for staff and students. UoM is a member of the N8 Research Partnership, made up of the 8 most research intensive universities in the North of England, with the aim of maximising the inter-institutional collaboration across the region.

Buildings
AHPs are located in Ellen Wilkinson and Zochonis Buildings, close to clinical bases at the CMFT. Since 2008, Zochonis facilities have benefitted from £800k investment in building and equipment. AHPs now have seven double-walled soundproof booths, evoked potentials, vestibular, hearing aid and dry bench laboratories, as well as clinical rooms shared with the Manchester Cochlear Implant team. Clinical research is also carried out at NHS and educational sites. Recent CMFT, Wellcome, and NIHR investment (£615k) supports development of audiology research facilities on NHS sites. The group also benefits from the excellent central facilities for human neuroimaging.

Dentistry has relocated to Coupland 3 Building adjacent to the University Dental Hospital (part of CMFT), with laboratory space embedded in AV Hill, Michael Smith and Core Technology Buildings and clinical facilities in Healing Foundation Facility in Manchester Royal Infirmary (CMFT) and Wellcome Trust Clinical Research Facility (WTCRF). In 2012 the Colgate Palmolive Dental Health Unit moved to new premises 100 metres away on Manchester Science Park. SofD will benefit from a planned £50m capital programme in 2015.

Nursing moved into purpose built accommodation in December 2007, following investment of £60m. This single site provides accommodation for all School staff in a state-of-the-art environment, fully equipped with up to date IT facilities, and a clinical teaching laboratory. Some staff also have offices in our partner MAHSC Trusts to facilitate interactions in the NHS. SNMSW shares the Jean McFarlane Building with the Institute of Population Health, (UoA2) a cognate fit. Research is also conducted at WTCRF, as well as NHS and social care sites.

Pharmacy moved in late 2007 into accommodation in the Stopford Building following £18m refurbishment and benefits from facilities that include an electronic prescribing suite, dispensing and aseptic suites, PC clusters, as well as wet laboratory space accommodating research in medicinal chemistry, pharmaceutics, microbiology, pharmacokinetics and drug metabolism, and pharmacology and therapeutics.

Common administrative infrastructure: The FMHS structure provides the framework for research management. An Associate Dean for Research (2010-13 from Dentistry) and a Deputy Dean for Strategy are supported by a Faculty Research Office with 9FTE administrative staff. The Faculty Research Group, comprising Directors of Research of the Health Schools and Directors of the six Research Institutes provide overall strategic direction. Within each School, direction is provided by a Professorial Director of Research, assisted by a School Research Committee and NHS representatives. UoA3 Directors of Research liaise regularly, with a monthly meeting. Following FMHS restructuring in 2011 research support services were reorganised to provide a fully

integrated structure comprising 7FTE Research Support and Finance Managers working in hub locations adjacent to the Schools. This reorganisation has permitted greater cover and co-ordination of service across UoA3 with clear improvements in support across the UoA as a whole. A FMHS-wide online MAHSC grant approval system replaced paper forms in 2012 streamlining grant application processes between UoM and NHS. IT and accountancy functions within the hubs permit PIs to track their project accounts. Research Intelligence and strategic support is provided by a Research Deanery comprising 7 research co-ordinators (5 postdoctoral) and 3 administrators. The University Research Office provides overarching support across Faculties and specialist support including an EU Office, compliance and risk management, research governance and data protection functions. As part of our PPI engagement we have developed a short research methods course for service users and carers, cited as a good practice example by NIHR MHRN and published by NICE as an implementation exemplar.

IT and equipment: In line with UoM IT strategy, we have undertaken an ambitious programme of IT upgrading. All staff have high specification PCs, and many have laptops, tablets and other mobile devices supported by robust wireless network available across most UoM locations including clinical areas, with plans to extend wifi cover beyond the "Oxford Road" corridor and into the city. IT supports desktop video and collaborative software applications and bespoke high quality video conferencing and access grid facilities. Clinical test equipment is available through our partner MAHSC Trusts. State-of-the-art specialist equipment is available across UoA3 including analytical NMR, confocal microscopes, mass spectrometers, specialist human performance monitoring facilities, gait analysis and activity monitoring sensors, bio-electrical impedance equipment for body composition. UoA3 researchers have access to a variety of NMR, CAT and PET scanning. UoM have three research-dedicated human MR scanners, two human PET scanners and two pre-clinical scanners (MRI and PET). Since 2008, a new 1.5T clinical scanner, a new clinical PET/CT and a pre-clinical PET/CT have been installed at the WMIC, with support from University Strategic Investment and AstraZeneca (£400k). MPS staff are responsible for all pre-clinical PET imaging carried out at WMIC. The University's 3T scanner at SRFT was upgraded and in 2012 the 1.5T MR scanner at the WTCRF was replaced with a 3T scanner with financial support from NIHR (£600k) and University Strategic Investment. In 2010 the 7T pre-clinical MRI instrument on the central campus was upgraded with support from BBSRC (£220k). MPS laboratories are juxtaposed to the refurbished Biological Services Unit (£20m), where associated in-vivo therapeutics, cognitive response and imaging (optical, SPECT and MR) work is carried out.

e. Collaboration or contribution to the discipline or research base

Collaboration: Since 2008, we have held interdisciplinary research grants with all six FMHS Institutes, and seven UoM Research Institutes. UoA3 researchers have collaborations with >150 universities/research institutions internationally and >40 other UK universities. Examples include: *UK*: Universities of Bristol, Cambridge, Cardiff, Edinburgh, Imperial College, KCL, LSE, Oxford, Lancaster, Leeds, Liverpool, Loughborough, Southampton, UCL, UEA. *North America*: USA, Columbia, Cornell, Emory, Harvard, Massachusetts, Minnesota, North Western, Purdue, Texas, UCSF; Canada, Manitoba, Toronto; Victoria BC; *Europe*: Belgium, Leuven; Denmark, Aarhus; Finland, Jyvaskyla, Tampere; France, Paris; Germany, Stuttgart, Heidelberg, DSHS Cologne; Italy, Bologna; Netherlands, Maastricht, Erasmus Rotterdam; Norway, NTNU; Sweden, Karolinska, Lund; Switzerland, EPFL; *Middle East, Africa, South America*: Israel, Hadassah, Tel Aviv; Kenya, Nairobi; Peru, Mayor de San Marcos, San Martin de Porres; *Asia and Australasia*: Australia, Curtin, Melbourne; China, Chongquing Medical; Japan, Koshien; NZ, Dunedin.

TABLE 3 Contributions to the disciplines and research base.

Prizes, Honours	Fellows learned professional societies etc	Journal Editors	Editorial Boards	Funding Panels UK	Funding Panels Non UK	UK Advisory NHS Govt & NGO	International advisory (Govt & NGOs)	Professional and regulatory body advisory roles	Keynote speakers
27	43	38	111	49	9	81	23	55	1107

Supporting research collaboration: UoA3 has a wide range of mechanisms to support and encourage collaborative research, including visitor and sabbatical programmes. We seek out collaborators to complement or strengthen the knowledge and skills of our team, and collaborators take a similar view in working with us. We identify priorities and lead networks to promote collaborative research with academics, health care providers, industry and service users (e.g. locally, CLAHRC; nationally, Patient Safety; internationally, ProFouND). All these mechanism also support interdisciplinary research, enhanced by our work with FMHS and UoM Research Institutes.

Contributions: UoA3 staff play very substantial roles in the wider research base, with significant collaborations outside UoM, and in terms of support for the research funding and publication process as journal editors, funding panel members, research reviewers. Staff play important roles in the professions and make social contributions by advisory roles. Collectively UoA3 members secured 27 prizes/honours or awards and have 43 professional society fellowships. We play major roles in the peer review process, serve as editors/associate editors (38) and on editorial boards (111). We serve on funding allocation panels (49 UK, 9 outside UK) and make societal contributions by serving on committees to advise government agencies, NHS and charities nationally (81) and internationally (23). We serve on professional society and regulatory body committees (55). Below we have selected examples to illustrate the range of this work.

Journal and publication work: *Selected journal editors*/*editorial board members:* **Aarons**, Journal of Pharmacokinetics & Pharmodynamics; **Bichenkova**, Journal of Biomolecular Structure & Dynamics; **Bryce**, Molecular Graphics & Modelling; **Cullum**, Cochrane Wounds Group; **Devlin**, Open Dentistry, Journal of Prosthodontics; **Freeman**, Medicinal Chemistry; **Galetin**, Current Drug Metabolism; **Hassell,** Journal of Health Services Research and Policy; **Hesketh**, Journal of Communication Disorders; **Lavender**, Cochrane Pregnancy & Childbirth Group, **Luker**, Health & Social Care in the Community; **McKay**, Journal of Association for Research in Otolaryngology; **McCracken** & **Young**, Journal of Deaf Studies & Deaf Education; **Neill**, Neuroscience Letters; **Plack**, Journal of the Accoustical Society of America; **Tickle**, Community Dentistry, BMC Public Health; **Watts**, Dental Materials, **Worthington**, **Clarkson**, Cochrane Oral Health Group.

Research funding: *UK funding panels* include: **Bryce**, **Horner**, **Glenny**, NIHR HTA Programme, **Attree**, **Deaton**, **O'Brien**, **Worthington** NIHR RfPB; **Todd**, **McHugh**; NIHR HSDR; **Ashcroft**, NIHR HTA Clinical Evaluation and Trial Prioritisation; **Hesketh**, NIHR HTA Maternal, Neonatal and Child Health Panel, External Devices and Physical Therapies Panel, Psychological and Community Therapies Panel; **Schafheutle**, Pharmacy Research UK; **Tickle**, NIHR In Practice Training Fellowships; **Williams**, Scientific Advisory Board Breast Cancer Campaign. *European and overseas funding panels* include: **Plack**, European Research Council Advanced Grants Panel; **Grande**, **Todd**, Federal Ministry for Education and Research, Germany; **Swallow**, **Todd**, Health Research Board, Ireland; **Bryce**, Bio-related Chemistry Panel, Academy of Finland; **Bryce**, EU Innovative Medicines Initiative; **Todd**, European Research Area in Ageing (ERA-Age2). *Research funding reviewing* includes all RCUK councils for research and fellowship schemes, NIHR (all research and fellowship funding programmes) and many overseas government agencies NIH, NZ-HRC, and charities including; CR-UK, Macmillan, Marie Curie, AR-UK, AR-NZ. *Research assessments* include: **Luker**, **Neill**, **Oldham** sit on UoA3 REF panel. **Luker** served on research assessment in New Zealand and the Nordic Countries.

Honours and prizes *Honours*: Her Majesty's Honours, **Lavander** DBE, **Cullum** DBE, **Noyce** CBE, *Honorary doctorates*: **Conti-Ramsden**, San Marcos National University, Peru; **Luker**, Lund University, Sweden, Alberta University, Canada; **Horner** Malmo University, Sweden. *Research prizes* include: **Galetin** European New Investigator Award, International Society for Study of Xenobiotics, **Hopkins**, Frith Prize, Experimental Psychology Society; **Noyce** Lifetime Achievement Award, Royal Pharmaceutical Society; **Penny**, Ebert Award, American Pharmacists Academy of Pharmaceutical Research and Science, **Stanmore** Best Paper Award British Geriatrics Society Falls conference. **Watts** Alexander von Humboldt Research Award, Germany; **Worthington** International Association of Dental Research Trendley Dean Award.

Discipline specific professional organisations **Noyce**, Chair Board of Trustees, Pharmacist Support; **O'Brien**, Chair, General Dental Council; **Stratford**, Chair, LH Gray Memorial Trust.

Invited presentations: Staff made in excess of 1100 invited (paid) presentations since 2008.