

Institution: Manchester Metropolitan University
Unit of Assessment: A3 Allied Health Professions, Dentistry, Nursing and Pharmacy
<p>1. Unit context and structure, research and impact strategy</p> <p>Overview</p> <p>The results of REF 2014 confirmed that we are amongst the most powerful and impactful centres for Allied Health research in the UK. We were the top 'modern' university for the power of our research (12th overall) and 100% of our impact was assessed as internationally excellent or above. This 2021 return demonstrates how our research environment has matured to encourage and support a significant increase in the volume, breadth and quality of our work.</p> <p>The number of submitted staff has increased from 65 (61.7 FTE) to 98 (91.7 FTE) including eight new Professors. We publish outstanding research in leading journals (Nature, Nature Cell Biology, Nature Communications, Circulation, Neuron, Augmentative & Alternative Communication, Brain, European Urology, Human Factors, and Spine). Income has increased to £5.94m with external funding from MRC, BBSRC, NIHR, Health Education North West, Horizon 2020 and esteemed charities including: Age UK, BHF, CF Trust, Alzheimer's Society, Diabetes UK and Nuffield Health. Our PGR community is large and diverse with 423 all-year enrolments from worldwide origins.</p> <p>Our region's devolved healthcare budget means that Manchester Metropolitan can contribute actively to the Greater Manchester Health and Social Care Partnership through our research and teaching. We have established collaborations and health interventions with all of our regional NHS Foundation Trusts in order to address the pressing needs of a diverse community with a focus on cardiovascular disease, healthy ageing, living with dementia and other long-term disabling conditions. Our strategy is to deliver applied and/or translational research that targets unmet needs regionally, nationally and internationally.</p> <p>Structure</p> <p>The staff included in our Allied Health Professions (AHP) submission are from the Centre for Bioscience (CBS) and the Centre for Health, Psychology and Communities (HPaC), situated within the University Centres for Research and Knowledge Exchange (UCRKE), established to advance health and social care research (see REF 5a).</p> <p>Centre for Bioscience (CBS)</p> <p>CBS includes 35 staff from the University's Faculty of Science and Engineering, one of the largest research-led science and technology educators in the UK. CBS researchers engage in interdisciplinary programmes exploiting next generation methodologies to improve population and personalised healthcare. CBS research is focused into four interlinking clusters, namely:</p> <p>Microbiology (Micro): Microbial communities in health, disease, hospitals and the food industry;</p> <p>Cardiovascular Research (CR): Vascular biology and platelet biology in disease pathogenesis;</p> <p>Ageing & Lifelong Health (ALH): Genetics, cell and molecular biology of healthy ageing; and</p> <p>Neuroscience (Neuro): Molecular mechanisms of neuropathology in the young and old.</p> <p>CBS has a management group led by <i>Prof. Tristan McKay</i> that includes representatives from each cluster, the Head of Department and Research Development Manager. CBS has an active External Advisory Board (EAB), chaired by Sir Alex Markham with international expertise from Prof. Roger Kamm (MIT, USA) and Profs. Sara Mole (UCL) and Cathy Shanahan (KCL) who both hold prominent roles in promoting gender equality at their host institutions. They meet with us biannually for an external strategic progress review.</p> <p>Centre for Health, Psychology & Communities (HPaC)</p> <p>HPaC includes 63 staff housed within the University's Faculty of Health Psychology and Social Care (HPSC). Our research is focused on the health and wellbeing of individuals and communities, regionally, nationally and globally, in collaboration with a diversity of stakeholders. Our emphasis</p>

on public involvement ensures that health and social care practitioners and service users are actively involved in all stages of research. HPaC includes five clusters, namely:

Communication Disability (CD): Augmentative and alternative communication, profound intellectual disability, and disability services in low-, middle- and high-income countries;

Global Perspective, Marginalisation & Thriving Communities (CPMTC): Sexual and reproductive health inequalities;

Mental Health (MH): Minimising abuse, complex trauma, restraint and conflict;

Physiotherapy: Musculoskeletal assessment and intervention; health service delivery and innovative public health approaches to improve patient outcomes, wellbeing and quality of life;

Stress, Health & Performance (SHP): Early life stress and relationship to mental health in adult life and health behaviour change.

HPaC is led by *Prof. Francis Fatoye* and a management group that includes the Faculty Head of Research and Knowledge Exchange, cluster Leads, a Senior Business Development Manager, Impact and Engagement Manager and Research Development Manager. External oversight is provided by a team of Visiting Professors including Prof. Martine Smith (TCD), Prof. Shakila Dada (Pretoria), Prof. Isaac Odeyemi, Dr. Andy McCann and Prof. Jackie Oldham (ex-Health Innovation Manchester).

Leadership teams from across CBS and HPaC meet regularly with the Pro-Vice-Chancellor for Research and Knowledge Exchange (RKE) and other senior colleagues to manage our health and social care agenda from a research and teaching perspective. This enables engagement in shared activity and allows us to take full advantage of the opportunities afforded by Health and Social Care Devolution across Greater Manchester.

Achievement of strategic aims

In REF 2014, we outlined a strategy for expanding research, including an increase in the quality and quantity of outputs, a growth in post-graduate student (PGR) numbers and increased external engagement. We proposed to focus on: (i) a fundamental understanding of biological systems underlying health and disease; (ii) development of disease biomarkers; (iii) computational modelling of function, disease and dysfunction; (iv) new methods of diagnosis; (v) design, implementation and monitoring of interventions; and (vi) the operationalisation of interventions within health services.

Since REF 2014, we have grown substantially and our strategic aims have been realised. The number of staff with a significant responsibility for research has increased by 50%. This is the result of a successful recruitment strategy and the quality of our progressive and supportive research environment. We have appointed 52.6 FTE including eight new Professors and 22 ECRs.

The volume of outputs has doubled with staff publishing 1,500 journal articles with partners from 67 different countries. PGR numbers have increased with 126 successful doctoral completions from UK and overseas students. Research income has also grown and we are winning bids from high-quality funders. We continue to make an important contribution to the strategic priorities of the discipline, and staff have been recognised for their efforts including: OBEs for *Profs. Laura Serrant* (nursing and health policy) and *Joy Duxbury* (mental health nursing). *Profs. Karen Sage* and *Laura Serrant* are members of the REF 2021 assessment panel.

Scientific breakthroughs

Cognitive health and wellbeing continue to be a central research theme, studying the way in which factors, including stress, can contribute to cognitive, motor, psychiatric, reproductive and metabolic decline during ageing. Our researchers are applying meta-analyses, genome sequencing and epigenetic evaluations alongside participant studies and surveys in order to understand how genes interface with lifestyle and environmental factors, and their contribution to mental health.

Our world-leading neuropsychology research includes studies on early-life exposure to stress and how violence affects mental health; epigenetics; prenatal depression and adverse outcomes for offspring and subsequent generations (outputs 1625, 2462).

Molecular neuroscience discovery research in state-of-the-art stem cell and transgenic mouse models of Alzheimer's disease (AD) has developed new understanding of how cell metabolism and synaptic plasticity results in memory loss and progressive neuronal cell death (outputs 1732-4). Research into the childhood neurodegenerative Batten disease has shown that similar molecular mechanisms affect dementias in the young and old.

Greater Manchester has the worst outcomes nationally for vascular disease, leading to heart attack or stroke. Our researchers have discovered new molecular mechanisms that result in stiffening and calcification of blood vessels, thrombus and atherosclerotic plaque formation, and how such plaques in blood vessels erode to cause a heart attack (outputs 1644, 1674, 1667, 1717, 1756). They have focussed on developing novel *in vitro* models by recapitulating vascular stiffening and vascular flow conditions across cells donated by patients with vascular disease.

Cognitive impairments, including stroke, can result in communication disability. Our researchers have developed innovative solutions in augmentative and alternative communications (AAC), including those that specifically benefit people in low- and middle-income countries (LMICs). In collaboration with IICP Kolkata, our researchers have instigated and evaluated a disability services initiative to low-income families across 97 sites in West Bengal. They have worked with the United Nations High Commission for Refugees (UNHCR) to support refugees with communication disabilities, and have increased awareness of their vulnerability to sexual and gender-based violence.

Our research improves sexual and reproductive health through the implementation and evaluation of community and public health programmes, working with healthcare providers and NGOs on national and international policy developments. Training and mentoring supported the establishment of the SLT profession in five African countries and Sri Lanka, and through leadership of Communication Therapy International, we have trained over 500 UK-based practitioners to work in LMICs and provided workshops for over 1,000 staff working with people with profound intellectual disability in Australia, Russia, South Africa and across Europe.

Our microbiologists use interdisciplinary approaches to minimise the negative impact of living with pathogenic bacteria in our modern society. We work with materials scientists, industrial partners and the NHS on the design of new surfaces with anti-bacterial properties for use in the food industry and healthcare (outputs 1662, 2434). Next generation DNA sequencing enables the rapid identification of bacteria, including discrete, under-represented but pathogenic strains. Our researchers have used this technology to reveal disease affecting alterations to the microbiome in the lung during exacerbations in cystic fibrosis (CF) and chronic obstructive pulmonary disease (COPD), as well as the gut in Irritable Bowel Syndrome (IBS) and Crohn's disease (outputs 1749, 1650-2). Our researchers have also conducted studies and developed questionnaires to assess pain, anxiety, mental health and quality-of-life for people with COPD through a cycle of exacerbations, in order to improve wellbeing.

Studies into the clinical and cost effectiveness of the UrgoStart wound dressing range in the management of chronic wounds was included in a dossier submitted to the NICE Health Technology Assessment committee that informed the economic models, which were pivotal in securing its approval.

Future Aims and Strategy

Aims

Our priority is to maximise meaningful impact from our high-quality RKE to deliver healthcare and social, environmental, economic and cultural benefits for our partner communities, businesses and governments, regionally, nationally and internationally.

Objectives

We will further increase the numbers and quality of our research-intensive academics, supported by a substantial increase in our estate and facilities, including the Faculty of Science & Engineering new build (to be completed in 2023). RKE activities will deliver an increase in external funding in established areas of internationally-recognised excellence. Our expertise is in developing strategic RKE partnerships with industry, healthcare and social care providers regionally, nationally and internationally. We will form larger institutional alliances with GM providers to improve health and wellbeing, with a focus on deprived and marginalised communities within the region. We will concurrently grow our innovations with LMIC to enable enrichment and social mobility.

Strategy

Operating within the University's RKE Strategy, we will foster an inclusive RKE culture and environment centred on 'Quality, Place, People and Innovation'. We will provide support and opportunities for all our research communities to develop the enabling of personal growth within our established priority areas and emerging areas of cross-centre synergy. We will focus on the delivery of health, wellbeing and social care research and knowledge exchange without boundaries.

Enabling impact

Our researchers work with health, social care and industrial partners to develop impact aligned to the needs of the Greater Manchester Devolution Agenda, the UK's Industrial Strategy and the UN's Sustainable Development Goals.

We receive support from two Impact and Public Engagement Managers, a Business Development Manager and a Partnership Manager. This level of expertise, alongside internal investment, ensures that impact is embedded into research plans from an early stage and underpins our impact case studies. The team delivers a rolling programme of staff development in impact-focused research design, impact evaluation, communication, and in writing impact case studies for REF submission; internal funding is available to support impact. Recent examples include support for *Duxbury's* work on the policy dimensions of her ground-breaking research on restraint alongside national health innovation think-tank, Policy Connect; *Powell* was supported to deliver national events as part of her *Healthy Universities* campaign and *Murray* (see ICS 5) has been supported for patient and public involvement in relation to AAC, with funding to engage with the All-Party Parliamentary Group on Assistive Technology.

Staff are supported to develop relationships with policy-makers by *MetroPolis*, a research-led think tank that we set up to amplify policy-relevant research in 2016. *MetroPolis* provides:

- Training from specialists, such as the Parliamentary Office of Science and Technology and Dods civil service policy professionals.
- Coordination of select enquiries.
- Travel grants to attend All-Party Parliamentary groups.
- Visits from policy-makers, and influential events. For example, *Sutcliffe* organised multiple events focused on the impact of his research into novel psychoactive substances with the GM Mayor, Andy Burnham (see ICS 3).
- Support for the Chancellor's Fellowship Scheme. For example, *Marshall* was awarded £9k to work alongside UNHCR in Rwanda to improve understanding of, and better meet the needs of, refugees with communication disabilities (see ICS 6).

We have a strong track record of winning external income to support the development of impact, including funding from business and industrial partners. For example, contract research in partnership with Urgo Medical and Smith+Nephew is reported in *Fatoye's* case study on health economics (ICS 4). Innovate UK KTPs have helped business partners to transform the profitability and effectiveness of their services including a 'Real World Evidence' project with Astellas Pharma (ICS 4) and an AAC KTP with ACE Centre (ICS 5). *Murray* also secured follow-on NIHR funding that enabled the further expansion of this impactful research.

Many researchers have contributed to the delivery of highly successful public engagement initiatives as a pathway to impact. *Verran* has an international reputation for the quality of her public engagement within microbiology, and coordinated our contribution to Manchester's Science Festival, Cheltenham Science Festival and the European Science Open Forum. *Verran* was awarded the American Association for the Advancement of Science award for Public Engagement in 2019 (ICS 2).

Our significant and wide-reaching support for impact will be sustained after REF2021 by four permanent posts that are already working alongside our staff, where we want to develop further political and societal benefits in the future. These plans include a continuing programme of training in impact literacy and the early identification of interdisciplinary areas of impact that align with our mission and strategy.

Support for interdisciplinary research

Staff regularly work across UCRKE and institutional interfaces to develop interdisciplinary research that addresses some of the biggest challenges facing society. Internal funds are made available for these activities and our researchers have led on the development of interdisciplinary networks that have fed into high-quality outputs and impact. For example, competitive internal funding of £40k to *Slevin* and *Tetley* established a network on 'Ageing and Dementia' that included artists, social scientists, architects and computer scientists. As a direct result of this activity, *Slevin* conducted follow-on work with computer scientists and chemists, leading to the successful award of two KTPs with Cambridge Medical Technologies to develop point-of-care testing and wearable devices that detect early markers of stroke and dementia.

At Centre level, strategic and competitive funding for staff travel and conference attendance has stimulated interdisciplinary collaborations and funding applications. *Murray* and *Goldbart's* collaboration with health economists Webb and Meads (University of Leeds), resulted in innovative use of discrete choice experiment methodology in communication disability research.

Progress towards an open research environment.

Our Open Research working group promotes a culture of open and reproducible research. This is done through organising guest speakers, workshops, regular meetings and connecting with other local and nationwide open research groups and organisations (e.g. the UK Reproducibility Network [UKRN]). The group also maintains a regularly updated resource for researchers that covers how to increase openness and reproducibility at all stages of the research lifecycle. Members of the group have played active roles in international collaborations including the Centre of Open Science 'SCORE' project and the Psychological Science Accelerator's Rapid-Response COVID-19 Project (PSACR).

We are compliant with the REF Open Access policy, and all articles and conference proceedings with an ISSN published after April 2016 are deposited in the University's institutional repository, e-Space, within three months of acceptance. The most downloaded outputs over the assessment period include publications on ageing and cognition (output 1665), nutrition and dietary supplements (output ref: 2432) and exome sequencing and genetics (output 1712).

AHP colleagues are encouraged to publish in journals supporting Green and Gold Open Access and to incorporate costs into their external bids. Colleagues can access funding for the Gold route where the outputs are particularly high-quality or have wider economic and societal implications. The Library holds a budget to support article processing charges and has contributed £166,000 to research in our unit within this REF period. The library also holds contracts and agreements with major publishing houses to discount publication costs in esteemed journals, whilst Marketing supports dissemination through professional social media channels.

The University's Research Data Management policy applies to all staff and PGRs, and is overviewed in REF5a. The University has invested £500,000 into a research data storage solution within the REF period that provides researchers with high-quality data protection, enabling secure data-sharing with national healthcare providers.

Research integrity

We are fully compliant with the Concordat for Research Integrity, and staff and students are aware of their responsibilities. *Prof. Goldbart* (to Oct 2020) and *Dr. Evans* are Heads of Research Ethics, and there are 53 staff in the submission who review applications and are active members of University ethics committees. Staff also lend their expertise to external ethics committees (*Fatoye* was appointed Chair of the Ethics and Data Monitoring Committee for an NIHR project initiated in 2013). All ethics applications (staff, PGR and UG) are submitted and reviewed via EthOS, an online system. Ethical and legal considerations are considered to be a core part of a researcher's development and are embedded in annual Personal Development Reviews (PDRs). Online training and face-to-face support is provided by a Research Ethics and Governance Manager (RKE), an expert in NHS sponsorship, patient and public involvement and clinical trials. Clear procedures are in place for reporting and investigating allegations of research misconduct. Our research often involves human participants, including vulnerable people, people with 'lived experience', distinct methodological challenges (e.g. involving children and young people with disabilities) and sensitive subjects. For example, *Murray's* NIHR proposal on AAC with young people has been cited by NIHR as an example of "best practice" for its sensitive approach to PPI and the involvement of end users as researchers.

We also have a Human Tissue Act (HTA) committee, including the Designated Individual and 4 Persons Designate, reporting into the University Research Ethics and Governance Committee. We conduct annual internal 'audits' of HTA compliance and have recently invested significantly in new systems, including an upgrade of storage freezers, alarm systems and inventory software. Local and national ethics approvals, as well as GMO approvals, Health and Safety risk assessments and COSHH forms, are centralised and secured electronically, accessed through individual password-protected portals using the data management system 'LabCup'. Our health research complies with the 3Rs philosophy where the use of animals in our active research is regulated, considered and minimised. There is no research conducted on live mammals and any project involving animal tissues sourced from collaborating institutions is subject to full ethical review prior to approval.

2. People**2.1 Development strategy for staff at all stages of careers**

Staff development and training are guided by the Concordat to Support the Career Development of Researchers. We provide time and support for colleagues to engage in a *minimum* of ten days professional development each year. Each cluster lead has responsibility for the staff development of their members, enriched by leadership training, grant-writing clubs, writing retreats, and structured development programmes, such as RKE Future Leaders and Good to Great, in addition to bespoke courses. External seminar series regularly include esteemed national and international researchers, such as Professor Shakila Dada (Pretoria), Professor Alison Wearden (University of Manchester) and Professor Tracy Cui (University of Pittsburgh), and we organise a vibrant programme of ongoing activity for staff and students, including annual UCRKE PGR presentation competitions and poster displays.

Staff benefit from diverse internal funding streams to support their personal development, many targeting ECRs. All Full Research members have access to an annual personal allocation of £500 to fund conference or skills/education-based course attendance. Manchester Metropolitan is a signatory to the revised Concordat for Career Development of Researchers and has held the EU HR Excellence in Research Award since 2013 (see REF 5a).

Mentorship and Personal Development Reviews

We firmly believe that mentorship is the most effective mechanism for staff development and wellbeing. All staff are assigned a senior researcher as mentor who has received internal training to provide informal peer review and general career guidance and advice regarding research ideas. Mentors support staff when they are writing individual research plans, as part of professional development reviews, to establish objectives for producing outputs, external funding applications

and academic citizenship. ECRs are encouraged to seek an esteemed external mentor within their research discipline to increase external visibility and reputation within the field.

Appraisal, Performance and Reward

The outcomes from mentoring and staff development processes feed into annual Performance and Development Reviews (PDR), conducted by Heads of Department and Directors of CBS and HPaC. A bespoke staff development plan is designed to balance personal circumstances and wellbeing alongside career development aspirations. UCRKE members with a focus on research have a minimum of 20% of their time allocated to research, and according to our REF Code of Practice, have significant responsibility for research. However, the PDR process enables high levels of performance to be recognised with a greater allocation of research time at each six-monthly review. Colleagues at the top of Grades 8, 9 or 10 (Lecturer, Senior Lecturer, Reader) may apply for additional increments to reward excellent research or impact activities. Professors have their pay reviewed annually as part of a 'banding' exercise that was introduced during this REF assessment period. This gives us the flexibility to reward outstanding contributions (including academic citizenship and impact) and to retain our top performers in ways that we could not have done previously.

ALH colleagues are provided with discipline-specific workshops run in conjunction with both the Faculty Head and the Pro-Vice-Chancellor of RKE, ensuring that the process is as open and inclusive as possible. Additional workshops are organised for Black and Minority Ethnic (BAME) and/or female colleagues to encourage all staff to pursue a research leadership role. Within AHP in this REF period, seven colleagues including six women have been promoted to Professor, and five staff have been promoted to Reader. A further 35 ALH colleagues have been promoted from Lecturer to Senior Lecturer.

Early Career Researcher Programme

We have a comprehensive RKE Future Leaders programme (see REF 5a) designed to provide a network of support for ECRs as they build towards the development of their first Fellowship or project grant application to UKRI or a major charity (e.g. Wellcome Trust, BHF, ARUK). The programme provides structured development activities around all aspects of RKE leadership and financial resources to engage in a group project. Participants receive workload relief to attend the sessions. Seven members of our unit (*Jack, Jones, Murgatroyd, Hamshire, Hidalgo-Bastida, Sutcliffe and Yeowell*) have benefited from the RKE Future Leaders programme during the assessment period; indeed, *Jack, Hamshire and Murgatroyd* have all subsequently been promoted to Professor and Reader positions. As well as mentoring, our ECRs benefit from funding that supports the development of activities. ECR funding has been used to pump-prime research support, access statistical support, enable workshop or conference attendance and has funded visits to other labs, particularly those of external mentors. In the past year, significant academic and administrative groups have been developed to support applications to UKRI's Future Leaders Fellowship (Unsworth) and the Academy of Medical Sciences Springboard Award (*Unsworth, Posner and Hawkins*).

Faculties have run discipline-spanning ECR showcase events (~3/year) presenting to staff, students, the Vice-Chancellor, Faculty PVC and RKE PVC. We also encourage ECRs to play an active role in their relevant professional societies; for example, *Page* won the UK Cardiovascular Society's award for Young Investigator of the Year in 2019.

ECRs engage in an Undergraduate RKE Internship Scheme (URKEIS) providing students with paid, 'real-world' engagement with a research project, designed to enhance a range of academic and employability skills. URKEIS routes have supported research in a range of interdisciplinary topics, including dementia, mental wellbeing, nutrition and cardiac rehabilitation. Student participants have often gone on to MRes and PhD studentships with the ECR as supervisor.

Internal support and investment for professional development

Staff across AHP have benefited from £170k of internal funding from schemes, such as the Research Accelerator (see REF 5a) and Health Research Accelerator Grants (HRAGs). This

funding enables staff to assemble preliminary data to support the development of an external funding proposal. HRAGs are offered to partnerships that include colleagues from the University of Manchester's Faculty of Biology, Medicine and Health. For example, *White* secured £10k from HRAGs with University of Manchester's Prof. Martin Humphries to extend analyses of flow patterns on endothelial cells. The funding enabled the generation of RNA datasets and initial bioinformatic analysis that fed into a successful £234k award from the British Heart Foundation in 2018 (PG/17/67/33218).

Sabbaticals, international exchanges and Global Challenges Research Funding (GCRF)

All AHP staff (fixed-term and part-time) can access financial support for international sabbaticals and staff exchanges to focus on significant work with a GCRF remit. These are two-way opportunities where we host international visitors; for example, academics from Nigeria, Kenya and Uganda visited us through an African Showcase event. This led directly to GCRF funding (*Fatoye*) to investigate spinal infection in physiotherapy caseloads across ten sites in Nigeria. Exchange visits between Prof. Shakila Dada (University of Pretoria) and *Murray/Goldbart* have led to several joint publications, international virtual workshops and a successful Erasmus+ bid that included technical, academic and PhD student exchanges.

Mershen Pillay's (UKZN) internally-funded visit led to a GCRF-funded project with *Jayes* on dysphagia management post-hospital discharge in rural communities in South Africa. *Marshall's* exchange arrangements with colleagues in Ghana resulted in THET-funded research and joint publications. To maintain these collaborations during the COVID-19 pandemic, *Marshall* established the online SLP Partnerships groups, now co-facilitated with Wylie (Australia), Rochus (Kenya) and Dada (South Africa).

Bull hosted two Ugandan pharmacists on a UK Aid-funded project on antimicrobial resistance. The project has led to a publication being submitted to the Journal of Antibiotics. *Correa-Muller* and *McKay* have developed a collaborative relationship with the University of Sao Paulo, Brazil. Funded through GCRF, we arranged reciprocal visits of academic teams scheduled for June-July 2020 that were postponed due to the COVID-19 pandemic and rescheduled for 2021-22.

Exchanges with business, industry or public sector bodies

We have a number of formal mechanisms to enable staff to exchange ideas with relevant partners. *Marshall* was able to use a MetroPolis Chancellor's Fellowship to take up an impact placement focused around her work on communication disability with the UN in Rwanda. We are one of the top-performing universities for KTPs and have delivered ten projects in exchange with partners, such as Astellas Pharma (*Fatoye*), Nuffield (*Powell*) and Cambridge Medical Technologies (*McKay*) during the assessment period. We also have 13 clinical appointments who facilitate an exchange of ideas and opportunities (see below).

Good to Great (G2G)

Initiated in 2018, G2G is a development scheme that is designed to expedite the internal promotion of talented staff on their pathway to professorship by providing access to significant internal and external resources (see REF 5a). G2G, which is led by the University's RKE Director and facilitated by a training and development manager, takes a 'needs-based' approach. Staff typically engage in an 18-month cohort-based programme, including certified external coaching, shared learning and development, including peripatetic membership of the University's RKE Committee. The seven AHP staff on the scheme (*Whitehead*, *White*, *Murgatroyd*, *Wilkinson*, *Dempsey-Hibbert*, *Yeowell* and *Marshall*) have collectively received £225,000 in support. For example, *Wilkinson* received funds for an 18-month PDRA, whereas the other participants received sabbaticals from teaching to focus on grant writing and to visit international collaborators. Two Professors and a Reader, all female (*Whitehead*, *Marshall* and *Yeowell*), have all gained promotion whilst on G2G.

Recruitment

Our recruitment policy has targeted professoriate and ECRs to increase research quantity and quality, combining leadership and potential. This strategy has resulted in the appointment of 55 AHP staff (52.6 FTE) during the assessment period.

Professorial appointments include:

Duxbury OBE: (Professor of Mental Health) Research on the exploration of stakeholder perspectives and implementation has led to a national and international focus on minimising restrictive practices, such as physical restraint and coercion across varied settings.

Serrant OBE: (Professor of Community and Public Health) A Fellow of the Queen's Nursing Institute and inducted into Sigma Theta Tau International Honor Society of Nursing, 2016. Research interests relate to community and public health, specifically health disparities and the needs of marginalised and 'seldom heard' communities.

Correa-Muller: (Professor of Neuroscience) Over 25 years of research experience in world-class institutes, including the University of Manchester and the MRC Centre for Synaptic Plasticity at the University of Bristol.

van der Gast: (Professor of Microbiology) Honorary Consultant Microbiologist within the Northern Care Alliance NHS Group and a visiting Chair at the University of Warwick. His research is focused on the role of microbiota in chronic lung diseases (cystic fibrosis, non-CF bronchiectasis, and COPD).

Enright: (Professor of Medical Microbiology) Research into the epidemiology and evolution of human bacterial pathogens, especially *Staphylococcus aureus* and its emerging resistance to antibiotics. Previous roles include Professor of Molecular Epidemiology at Imperial College London.

McKay: (Professor of Stem Cell Biology) Having held academic posts at the world-renowned William Harvey Research Institute, QMUL and the University of Manchester, his research applies stem cell biology to understand cardiovascular and neurological diseases.

Sage: (Professor for Applied Clinical Research) Expertise in speech and language therapy, and interdisciplinary, clinically-applied collaborative research. Previously Professor of Allied Health Professions at Sheffield Hallam and Director of the Bristol Speech and Language Therapy Research Unit with a wealth of successful completions and external research grants.

Ollier: (Professor of Immunogenetics) appointed on a 0.2 FTE contract specifically to develop external relationships with clinical partners regionally and nationally. As well as holding an Emeritus Chair at the University of Manchester, he was integral in setting up the UK Biobank and spent seven years as R&D Director at Salford Royal NHS Foundation Trust.

ECR appointments include: *Bull, Dobbin, Turnbull, Willmott, Hawkins, Lewis, McLaughlin, Page, Posner, Unsworth, Dunn, Erskine-Shaw, Liu, Longley, Opdebeeck, Ostashchenko, Paltoglou, Pilkington, Sirri, Stamou, Steels, Haines and Jayes*.

This recruitment, together with staff development activities and high levels of retention, have led to significant overall research capacity. In addition to 98 staff with a significant responsibility for research (SRR), we also have circa. 200 PGRs, 16 associate members who are working towards achieving full research membership and 17 research associates and assistants. Principles of equality, diversity and inclusion are embedded throughout our recruitment processes: 30 of our new appointments are women.

We support staff at every stage of their academic career, as reflected in our staffing contract profile (Table 1)

Professor)	Principal Lecturer and Reader	Senior Lecturer	Lecturer, Research Fellow
17%	14%	41%	28%

Staff contract level profile (Table 1)

All of our staff with SRR in UoA03 are on permanent employment contracts. The retention of our staffing base throughout the assessment cycle (81% excluding retirements) represents high levels of satisfaction with our research environment for a 'modern' university. We have a large volume of ECRs (24% of our submission), which evidences a strong and sustainable talent pipeline.

Induction for new staff and PDRAs

All new staff undertake departmental and RKE induction programmes, providing critical knowledge on research conduct, integrity and ethics, data protection, health and safety, procurement and grant management. Further institutional training is provided on PhD supervision, post-graduate examining, chairing assessment panels and implementation of our equality and diversity policies. Our PDRAs and KTP associates are automatically members of the appropriate UCRKE. Like all permanent staff, fixed-term contract staff are supported by the PDR system, allocated mentors and have access to the annual £500 fund to attend research/skills-development/networking conferences.

Effective integration of clinical academics

We have recruited Clinical and Practice Research Fellows from the NHS to increase the profile and capacity of our AHP research. We provide an infrastructure and research environment for clinical academics to engage in research, conduct surveys or systematic reviews, and apply for grants, e.g. NIHR, RfPB and the Chartered Society of Physiotherapy's Research fund. Our links with the NHS and other healthcare providers through Health Innovation Manchester and MAHSC provide an optimal environment to translate research outputs into everyday clinical practice to meet the needs of patients and service users.

We have 13 Clinical Visiting Professors (*Carley, Kirwadi, Bhatti, Sheen, Serracino-Inglott, Mitra and Bilal*, all Manchester University NHS FT; *Jude*, Tameside Hospital NHS FT; *Bakerly, Limdi, Green and Kalra*, Salford Royal NHS FT; and *Shokrollahi*, Whiston Hospital, St. Helen's and Knowsley NHS FT). *Stephens* has been appointed to a Clinical Research Fellow position to continue his working relationship with the research group while he developed an NIHR CDRF application. *Cuff, Hanson, Hasan* and *James Pilkington* are currently enrolled as co-funded PhD students whilst continuing their NHS commitments. This is in addition to many clinical collaborators working within vascular surgery, cardiac rehabilitation, diabetes, hypertension, Lupus and rheumatology, renal disease, interventional cardiology, lipidology, platelet biology, genomics, imaging and acute coronary syndrome.

2.2 PGR Students

Strategy

PGRs play a vital part in our research community. We recruit high-quality students and support their research development while advancing their skills and employability through in-depth personalised support and training through the Graduate School, Faculty Heads of Research Degrees and UCRKEs. We have delivered 125 doctoral completions in the assessment period.

Recruitment of doctoral research students

During the assessment period we have recruited 423 PGR students from the UK (75%) and internationally (e.g. Thailand, Finland, Cyprus and Turkey). A relatively large proportion of our students (50%) are part-time and 60% of our PGRs are female. 12% of our PGR students have a known disability, which reflects the quality of our support for reasonable adjustments and the results of the 2019 Postgraduate Research Experience Survey (PRES), in which we were ranked in the top quartile for overall quality for respondents with a disability. 25% of PGRs identify as BAME, which also reflects our strong performance in PRES 2019 where we were ranked in the top quartile for quality overall from BAME respondents.

Funding for studentships

We have been awarded a number of competitive and prestigious, fully-funded PhD studentships from the BHF and NC3Rs, the Stroke Foundation and NIHR within this REF period. We also operate a match-funded PhD studentship programme to encourage development of collaboration with industrial partners, and have received funding from various organisations and charities, including Touchlight Genetics, Cystic Fibrosis Trust, Manchester University NHS FT.

We are members of the University Alliance Doctoral Training Programme for Biosciences and we have a current cohort of 18 full-time PhD students. We run Professional Doctorate programmes in various fields of Health and Social Care for NHS staff. For example, the Higher Specialist Scientific

Training (HSST) is a five-year, practice-based education and training programme, supported by a part-time professional doctorate (DClinSci) and, where appropriate, Medical Royal College qualifications. The Doctor of Clinical Science Network aligns with national HSST curricula and is held within a partnership that includes the Universities of Manchester, Salford and Liverpool. Manchester Academy for Health Scientist Education (MAHSE) includes the Scientist Training Programmes (STP) that train Clinical and Biomedical Scientists nationwide. The MAHSE Network shares a common structure with the published National School of Healthcare Science Curricula, i.e. Leadership and Professional Development, Specialist Scientific and Clinical Programme and Research, Development and Innovation.

Monitoring & support mechanisms linked to successful completions

PGRs have a minimum of two academic supervisors, including a Principle Supervisor, who support the academic development of the student's research and provide guidance on professional development opportunities. 100 hours of workload is allocated to the supervisory team to enable timetabling of regular meetings, overseeing ethics, and governance and thesis development. *SkillsForge* documents and manages supervisory meetings, training and educational progression milestones online. An Application for Registration takes place after three months (for full-time study) and a Progression Review or Transfer of Registration takes place after 12 months (full-time). Independent academics scrutinise annual progress reports and conduct an informal *viva voce*, in which any issues can be raised. All PGRs are expected to submit within four years (pro rata for part-time students).

The 2019 PRES results underlie the confidence that our PGRs have in the progression arrangements and we are comfortably ranked in the top quartile nationally for progression 'quality' across responses from PGRs in relevant disciplines (e.g. Public Health, Allied Health, Psychology and Biological Sciences). We were 6th out of 45 universities for the progression measure in health-related disciplines. We have achieved 126 successful doctoral completions within this REF period.

PGR support and training

UCRKEs work with the Graduate School to provide training for PGRs in research skills focused broadly on the Vitae Researcher Development Framework (RDF) (see REF 5a). RKE funding is available for specialist in-house or external skills workshops, and visits to external collaborators to build competency in research techniques. We offer seminars and training on specialist equipment and techniques (e.g. Illumina, Promocell and Luminex). UCRKE host away days for PGRs, focused on career planning and offer expert practical and theoretical instruction in laboratory techniques delivered by staff.

PGRs are encouraged to develop academic skills by joining professional societies and public engagement events. Clusters run regular meetings and journal clubs, in which PGRs have opportunities to present their research. These meetings contribute to the wider research culture by providing opportunities to share good practice, encourage 'team' problem-solving and the development of communication skills. The 2019 PRES results highlight the quality of our training and support. We were ranked in the top quartile nationally for research skills, professional development and responsibilities in biological sciences, and psychology and neuroscience, and in the top quartile for professional development in public health-related disciplines.

2.3 Equality and diversity

Diversity within the submission

We have made considerable progress in improving equality and diversity within AHP, with a particular emphasis on gender and ethnic representation at senior roles. Eleven of our 18 Professors are women (61% compared with 21% in REF2014), two of our Professors are BAME (11%) and our submission includes 53 women (55%) compared with 50% in REF2014. We have inspirational staff who are leaders in the sector's wider approach to equality and diversity. *Serrant* is Chair of the Chief Nursing Officer for England's BME Strategic advisory group and ambassador for the Race Equality Charter for Higher Education. In 2017, *Serrant* was listed as the eighth most influential Black person in the UK by the Powerlist 2018. Full details of the equality and diversity

in our submission comparing submitted staff with the overall population and sector-wide data (from Advance HE's 2019 Equality Report) is included in Table 2 below. The Allied Health Professions sector is heavily weighted towards women (75%) and not gender-equal (50:50). Our UoA03 submitted staff are 55% female, representing a more equal gender balance than the sector. Our BAME representation is in line with the sector but requires improvement through our Equality and Diversity directive, as described below:

Protected characteristic	% of submitted staff (REF 2021)	% of staff in overall eligible population (REF 2021)	% of average academic staff in Allied Health in wider sector (Advance HE Equality Data 2019)
Female	55%	65%	75%
Male	45%	35%	25%
Declared disability	5%	5%	7%
White	88%	86%	91%
<i>Total BAME:</i>	9%	13%	9%
Black	2%	4%	-
Chinese	2%	2%	-
Asian	1%	5%	-
Mixed / Other	4%	3%	-
Unknown	3%	1%	-

Table 2: Equality data in Manchester Metropolitan's Allied Health submission

Flexible working

We facilitate temporary part-time working, compressed hours, job share, homeworking and career breaks, combined with a promotions scheme, which ensures that colleagues are not penalised for career breaks. Timetabling arrangements support colleagues with caring responsibilities, while all meetings and research seminars are held during normal working hours. Since the COVID-19 pandemic, remote working has become embedded within our department, balanced with access to research laboratories and face-to-face teaching.

We recognise the effect that equality-related circumstances can have on an individual's ability to conduct research. Following disclosure of an equality-related issue, we adjust our expectations in terms of workload and productivity. ECRs have reduced expectations of research outputs. We make similar adjustments for colleagues with caring responsibilities, chronic disabilities, including mental health issues, and those returning to work after a period of sickness or family-related absence.

Career pathways and other forms of support

Part-time and fixed-term staff have access to the same support and progression systems as full-time staff, including PDR, conference and career development funds, and training/development opportunities in laboratory techniques, teaching qualifications and ECR development.

Returning from a period of absence and the management of caring responsibilities

We have policies to support staff who are returning from illness or other long-term family-related absence. We have a generous annual leave allowance, with enhanced maternal, paternal and adoption leave in addition to unpaid parental leave if required. For example, we adjusted expectations of two staff members in the submission who returned from family-related leave. The RKE Delivery team ensures that negotiations for extensions or pauses can take place with external

fundings, and staff returning from extended leave for whatever reason have access to confidential routes to disclose circumstances that can lead to adjustments in expectations.

AHP colleagues who have taken maternity leave in the current REF period include; *Whittle, Gregg, Patel, Opdebeeck, Erskine-Shaw, Fawcett, Jones and Edwards*. Recipients of paternity leave include: *Evans, Carroll, Ahmed, Chatzidamiano, Harkin and Bones*.

Wellbeing of staff and students

All staff have access to the Lifeworks portal for counselling, confidential advice and support for personal issues. Lifeworks is a fully-integrated wellbeing platform that provides everyone with access to discounts and wellbeing assistance seamlessly via the website and a mobile app. Regular meetings with mentors and research theme leaders help us to identify staff that might need to be signposted for support where appropriate.

We have pioneered efforts to support the wellbeing of staff and students right across the Higher Education sector. The UK Healthy Universities network is co-chaired by *Powell*. It has 97 members to which it offers peer support and guidance around implementing a whole-system approach to health, wellbeing and sustainability (healthyuniversities.ac.uk).

Equality and Diversity in the REF submission

The AHP coordination team is made up of the RKE Head of Research Environment & Impact, the two Directors of UCRKE and four senior academics across AHP. The team constitutes four male and three female staff, including one BAME Professor, reflecting representation across our staff. The AHP coordination team has aimed to be fair, transparent and inclusive, following the University's Code of Practice to guide decisions around the make-up of our submission, and the team have completed 'Managing Diversity', 'Equality and Diversity Essentials' and 'Unconscious Bias and REF2021 training'. All colleagues with significant responsibility for research (distinct from KE activities), and who are working as independent researchers have been included in the submission. Equality and diversity were assessed across the output selection with 50% outputs from female staff and 50% outputs from male staff. Of the seven impact case studies, three are led or co-led by female staff.

All colleagues have been made aware of the processes surrounding requests for a reduction in output expectations; three staff came forward voluntarily and adjustments to our internal expectations of their productivity have been made. We have opted not to seek any reduction in the overall volume of outputs since there is enough scope within the revised rules for us to manage the impact of individual circumstances.

3. Income, infrastructure and facilities

3.1 Funding & strategies for research income

Strategic investment in staff, including new appointments, development schemes and excellent support from our Research Development Managers has resulted in 144 external research awards totalling £5.94m. We have also secured over £1.2m in knowledge exchange awards. There has been a steady year-on-year growth in external income since 2013/14 (£250k) to 2019/20 (£1.039m).

Research income has been awarded from NIHR, MRC, BBSRC, Health Education North West, Horizon 2020 and esteemed charities, such as Age UK, BHF, CF Trust, Alzheimer's Society, Diabetes UK and Nuffield Health. We have continued to acquire funding from the EU (Horizon 2020 £158,000 *McKay*) and UKRI through MRC (£224,000 *Murgatroyd*), BBSRC (£437,000 *Enright*) and ESRC (£161,000 *Toseeb*), as well as recent success with NC3Rs (£275,000 *McKay, White and Jones*).

Our cardiovascular scientists have developed a strong relationship with the BHF (£520,000 *Alexander, White and Jones*). Clinical and social care-facing research has been funded through NIHR (£722,000 *Murray*), NHS Foundation Trusts (£351,000 *Fatoye, Wilkinson and Hamshire*),

CSP Charitable Trust (£153,000 *Yeowell*), Health Education North West (£520,000 *Jack*) and Nuffield Health (£285,000). Health education funding and health associated charities (£476,000 *Duxbury* and *Marshall*) have contributed to further external income.

Our funding portfolio remains diverse (see Table 3 below) but the majority of our income is from UK business, industry and government sources, including a large and successful KTP portfolio comprised of 12 projects worth £2.4M. We have generated contract research income (£403,000 *McKay* and *Fatoye*) working with national and international companies.

Diversity of Income Sources

Source of Income	BEIS Research Councils	NIHR funding	UK Charities, Open Competition & other	UK Govt, Industry & other UK sources	European Union
Percentage of Income	10%	12%	20%	53%	5%

Table 3: Diversity of income sources

Major competitive awards

'Identifying appropriate symbol communication aids for children who are non-speaking: enhancing clinical decision making' NIHR (14/70/153), £722,000 (2017)

Led by *Murray*, this major collaborative study with Barnsley NHS Trust and the University of Leeds has developed vital information about the decision-making process that professionals use when selecting appropriate communication devices for children (see ICS 5).

'HEE Development Of A New Model For Inter-Professional Learning (IPL) With Birley Place' Health Education North West, £520,000 (2019)

Led by *Jack*, this project plays an important role in the opportunity to 'do things differently' as part of the devolved Greater Manchester health budget; how inter-professional learning and integrated team working can transform the undergraduate health and social care curriculum.

'A realist review of complex interventions to prevent and reduce the use of restrictive practices on people with learning disabilities in hospital settings' NIHR £325,000 (2020)

Duxbury leads this investigation into the mechanisms that reduce the use of restrictive practices on adults with learning disabilities in NHS and independent sector settings including adults with learning difficulties who also have autism or mental health co-morbidities.

"Psychological, social and biological predictors of child mental health and development: a longitudinal study of shared and distinctive risk and protective factors in UK & India" MRC (MR/S036466/1) £224,000 (2019)

Murgatroyd is collaborating with the University of Liverpool on this £2.2M project that uses a culturally-sensitive longitudinal study to uncover the early origins of mental health amongst 60M affected children in India and other LMICs worldwide.

Strategy for external research income generation

Our strategy for external research income generation rests on the following principles:

The development of fewer, larger bids from all staff with SRR:

Engagement with funding agencies and associated priority-setting exercises, plus detailed information-gathering by RKE, has resulted in a more strategic approach to bidding. Researchers are encouraged to bid more selectively, for larger grants (relative to discipline norms) and work with BDMs to target more ambitious KE projects. *Worktribe* ensures that intelligence on bid outcomes can be shared. Robust peer review processes, starting with formal UCRKE support and scrutiny, enhance the quality of bids, and share expertise across the staff team.

A careful pathway of mentoring and support for ECRs:

Our ECR support programme was described in Section 2. We support ECRs with intensive peer review and mentoring that provides a pathway of support towards that all-important first grant application. Schemes, such as RKE Future Leaders and G2G, provide a clear and transparent pathway towards career progression.

Playing our part in the Greater Manchester Devolution agenda:

We have won large awards for projects that pioneer different approaches to training the GM health and social care workforce, and our large research and teaching nexus provides a fantastic opportunity for us to feed research-led innovations into a new way of doing things across GM. Our large and expanding KTP portfolio is enabling us to translate new ideas into impact that benefits north west SMEs and we will continue to grow this activity into the future.

Using knowledge of funders more strategically:

As our research expertise has grown we are able to rely on an expanded pool of academic leaders with detailed and specific funder knowledge. We have used this experience to form 'funding teams' that work alongside our Research Development Managers, to provide detailed critical appraisal of proposals throughout the application stage. This approach has been successful for us with BBSRC, where we have two colleagues who are members of BBSRC's C and D Committee and with NIHR through membership of the British Academy of Childhood Disability's Strategic Research Group.

The use of internal investment to support external income generation:

AHP researchers receive significant internal funding to support early stage ideas. The Strategic Opportunities Fund (SOF) and HRAGs have been used with precision to pump prime activities that have been developed into full external proposals. SOF investment of £40k was used to progress cross-disciplinary capacity for tackling dementia in the community, which led to collaborations between researchers investigating the underlying biology of vascular dementia (*Slevin, Krupinski*), developing new MRI modalities for early diagnosis of dementia in Parkinson's disease (*Ray C24*), and *Murgatroyd*), epidemiological trends in dementia (*Lees*) and living well with dementia (*Tetley - retired*), including the intersection of arts and health (*Parkinson D34*). In 2018, further SOF investment of £194k enabled ECRs to pursue projects in fibrosis (*Pritchett*) and anti-microbial drug development (*McLaughlin/Butler*) leading to UKRI applications and high-quality outputs.

Exceptional support from the RKE Directorate:

Our Research Development Managers who attend management meetings work with us on our long-term funding strategy. We have access to an International Research Development Manager and an experienced delivery team that enables us to fulfil our funder responsibilities. These relationships have been a key part of our success and provide us with confidence, capacity and support.

3.2 Infrastructure

Research and Knowledge Exchange Directorate (RKE) and Professional Services

A modernised and expanded RKE Directorate provides centralised support including Finance and Legal Services, Information Systems & Digital Services (ISDS), and Communications and Marketing, whilst AHP researchers are specifically supported by the following staff:

Faculty Research Degrees Administrators working with GS to facilitate PGR progression;
Commercialisation & Contract Officer;
Two Pre-Award Research Development Managers;
Post-Award Project Delivery Team;
Two Research Impact and Engagement Managers;
International Research Development Manager;
Research Ethics and Governance Manager;
Two Business Development Managers;
Industry Partnership Manager;
An award-winning KTP team;

Two Press Officers and two HR Business Partners;

The RKE Directorate provides management of RKE IT systems including:

Symplectic - maintenance of scholarly outputs and open access compliance;

Worktribe - external funding applications;

EthOS - research ethics and governance for staff and students;

SkillsForge - PGR student journey;

LabCup - laboratory management; equipment booking, consumables and sample management, health and safety, and HTA compliance;

SciVal - research benchmarking and reporting.

Technical Support

We receive excellent support from a team of 30 FTE technical professionals organised across research-facing teams (e.g. microbiology, bioscience, cell biology, food science) who fully understand our research priorities. Research Technicians manage our core facilities and provide hands-on expertise through different mechanisms, including secondments onto projects and cost-recovery through KE activities. Recent collaborations with technical staff have included sequencing of pathogen-infected samples for Health & Safety Executive (*van der Gast*) and the development of novel DNA technologies with Touchlight Genetics (*McKay*). We are a signatory to the Science Council and Gatsby Foundation's Technical Commitment, for which the PVC RKE is the institutional lead.

IT Infrastructure

Research activities across UCRKEs, including next generation DNA sequencing and MRI scanning, generate huge quantities of digital data. We have a new £500k Research Data Storage facility that provides a data storage solution (multiple Petabytes) managed centrally by ISDS.

Library Services

Our librarians provide expertise in particular fields, in addition to Research Support Librarians who provide access to 349 electronic databases, including *BioMedCentral*, *CORE*, *PubMed*, *Scopus*, *Web of Science*, *LLBA* and *Science Direct*. Research Support Librarians assist with systematic reviews and provide guidance on publishing routes, copyright, enquiries around Open Access and Research Data Management, as well as offering training to academic and PGR students. The library manages Green Open Access through the *e-Space* repository (integrated with *Symplectic*) and administers funding for APC payments for Gold OA.

3.3 Specialist facilities

Our research facilities are spread across two Manchester-based sites on the University's All Saints campus. The award-winning £139M Brooks Building opened in 2014 and is home to research in health and social care. Bioscience research is carried out in the John Dalton Tower, which consists of eight floors of combined research space. Our research is underpinned by six critical facilities for Imaging & Electrophysiology, Genomics, Cell Biology, Tissue Processing, and Neuro-Cognitive and Movement cores, maintained and managed by TS.

Imaging & Electrophysiology Core: Scanning electron microscopy, a Leica SP5 and a brand new Stellaris confocal microscope, a Leica DM1600B live cell imaging microscope, three fluorescence microscopes (inverted and non-inverted), two integrated cell and tissue electrophysiology rigs and a micro-electrode array rig. This facility also houses an integrated Class II cell culture cabinet and CO₂ incubator to enable smooth transition of sensitive cell experiments to live cell imaging, electrophysiology and calcium imaging experiments.

Genomics Core (GC): DNA sequencing is supported by Illumina NextSeq 500 and two Illumina Mi-Seq machines, a Fluidigm EP1 sequencer, five qPCR thermocyclers and a QiaCube DNA extraction machine. The GC is run by technicians and is isolated from other cell and molecular activities to avoid contaminations. GC contains dedicated laboratory areas for library preparation activities for next generation sequencing.

Cell Biology Core: Flow cytometry is supported with a BD Biosciences FACSVerse and new FACSCelesta and Miltenyi MACSQuant Analyzer 16 instruments, four multi-wavelength plate readers, a Luminex multiplex plate reader and a Seahorse XFp metabolic bioanalyzer.

Tissue Processing Core: The core incorporates two Leica Cryostats, a Leica VT 1200s Vibrotome, two Microtomes, a Leica HistoCore PEARL tissue processor, a Tissue Tek embedding station and a Leica ST5020 Autostainer.

Neuro-Cog Core: Facilities for brain imaging and electrophysiology (fNIRS, EEG, EMG, EDA, HR, PPG), brain stimulation (TMS and tDCS), eye-tracking and VR (EYEFramesceneBI, Tobii), neuropsychological testing [library of highly standardised neuropsychological tests, commonly used in clinical settings and research, covering a range of ages (0-90 years) and skills (memory, intelligence, personality, executive functions, sensorimotor and behavioural development)] and Observation Lab (Observer XT, Noldus).

Movement Core: Equipped with six Qualysis camera systems, a force plate, two FDLite platforms (portable force plates) that enable data collection outside the laboratory. A Quattro EMG sensor (Delsys) and an ultrasound machine.

Shared use of research facilities

Our partnership with Health Innovation Manchester provides unrivalled access to state-of-the-art equipment, expertise and clinical samples throughout Greater Manchester's HEIs and NHS Teaching Hospitals. Our researchers have access to animal facilities, specialist DNA sequencing, imaging and proteomics core facilities at the University of Manchester. We have access to City Labs, which is a cluster of diagnostics, med-tech businesses including the Stoller Biomarker Discovery Centre. Through established collaborations and visiting academics our neuroscience researchers have access to two of the most substantial post-mortem brain banks at Salford Royal NHS FT and El Hospital Universitario Mutua Terrassa, Barcelona.

4. Collaboration and contribution to the research base, economy and society

Northern Clinical Networks

The University of Manchester NHS Foundation Trust: Lung (CF) and gut (Crohn's, IBS) microbiome (*van der Gast*), biomarker and mechanistic analyses on Lupus/rheumatological diseases (Kellgren Centre, *Wilkinson and Alexander*), general surgery and hernia repair (*Sheen, Wilkinson, Pritchett and Alexander*), vascular surgery (*Serracino-Inglott, Wilkinson, Weston and Alexander*) and diabetes (*Wilkinson, Weston and Alexander*). Vascular function studies (*Bilal, Azzawi and Alexander*) and platelet biology (*Jones and Unsworth*). Reproductive health in the ageing population (*Carroll and Murgatroyd*).

Northern Care Alliance: (amalgamation of Salford Royal and Pennine Acute NHS Trusts.) Lung (COPD) microbiome analyses (*van der Gast*). Renal (*Azzawi & Kalra; Shalamanova, Wilkinson and Mitra*) and cardiac/critical care (*White/Green*).

Whiston Hospital: Retrospective data collection study with the International Burns Injury Database (IBID), EDMS (electronic data management system) and Telepath of any patients over the last fifteen years with 10%-40% TBSA burn injury (*Dempsey-Hibbert*).

Barnsley Assistive Technology Service: Identifying appropriate symbol communication for children who are non-speaking: enhancing clinical decision making (I-ASC—*Murray*)

North East Back Pain Pathway: Evaluating patients with chronic low back pain and radiculopathy (*Fatoye*).

Ainley is Director of the MAHSE (<https://mahse.co.uk>). Established in 2012, MAHSE is a partnership between Manchester Metropolitan and the universities of Manchester, Salford and Liverpool, as well as leading Healthcare Scientists (HCS) from NHS Trusts. It has developed to

include other universities that work together to deliver a range of Healthcare Scientist training and DClinSci programmes.

We are partners in two industry-sponsored clinical trials: i) Randomised clinical study investigating the effect of a novel HDx therapy on markers of vascular health compared with conventional on-line haemodiafiltration (MODAL study, NCT03510520) in collaboration with TheraNova (*Mitra, Alexander and Wilkinson*); and ii) Comparison of mesh fixation techniques in elective laparoscopic repair of incisional hernia – ReliaTack™ -v- ProTack™; prospective double-blinded randomised controlled trial (NCT03434301) with TACKoMesh (*Sheen, Alexander, Pritchett and Wilkinson*). *Sheen* is also collaborating on a study on wound infection following Hepatopancreatobiliary (HPB) surgery – a measure of predictive surgical and transmission factors on patient outcomes (*Whitehead, Dempsey-Hibbert and Butler*).

A leading example of national/international collaboration is *van der Gast*'s lung microbiome research, funded through governmental and charity sources, including the CF Trust. He works locally on COPD with Professor Bakerly, (Salford Royal Foundation Trust), and on CF projects with local (Drs Horsley and Jones - Manchester Adult CF Centre, Wythenshawe), national (Drs Carroll and Daniels - Southampton Adult CF Clinic, Southampton General Hospital) and international collaborators at Dartmouth College, New Hampshire and the University of Pennsylvania, USA. He is also leading a gut microbiome in CF-focused project, working with Professor Alan Smyth (Consultant in Paediatric Respiratory Medicine) and Dr Giles Major (Consultant Gastroenterologist), both of Nottingham University Hospitals NHS Trust. *van der Gast* has been invited to be a Government Scientific Advisor, providing expertise and advice to the Department of Health and Social Care (DHSC) and Department for Environment Food & Rural Affairs (DEFRA) on the national COVID-19 wastewater surveillance programme.

Cordero is collaborating with Professor McGlone (Professor in Neuroscience, Natural Sciences and Psychology, LJMU)'s group, investigating how mood and sociability influence social touch responses in relation to C-tactile afferents (CTs).

European and international partnerships

AHP colleagues collaborate with European partners through Erasmus and EU Horizon 2020 programmes, and internationally through BBSRC (University of Sao Paulo, Brazil), MRC (NIMHANS, Bangalore, India) and GCRF (University of Sao Paulo, Brazil) projects.

Swiss National Centre of Competence in Research (NCCR) Synapsy: Network of 20 excellent laboratories aiming to understand the synaptic bases of mental disorders (*Cordero*).

Alzheimer's Disease (AD) Consortium: The Brain Banks at Salford and Mutua Terrassa, Barcelona, Spain are two of the largest such facilities worldwide. *Krupinski* is Head of Department of Neurology at Mutua Terrassa and holds a 0.2 FTE Professorial appointment with Manchester Met. This collaboration provides our researchers with unrivalled access to AD samples from patients undergoing treatment, involved in clinical trials and post-mortem material.

BATCure EU Horizon 2020 consortium: Developing new therapies for a rare but fatal neurological disease called 'Batten Disease' (BD). Collaborating with academics and industry partners across seven different European nations, the consortium has developed new lead drugs and carried out pre-clinical efficacy studies for gene therapies (€6M funded). As a consequence of this funding, *McKay* has developed the largest repository of BD patient-induced pluripotent stem cell (iPSC) lines in the world, freely accessible for any academic studying BD.

Whitehead is currently collaborating on developing innovations around hygienic surfaces for food development with ALPhANOV, (France), the University of Copenhagen, University of Porto, University Medical Centre, Groningen, Universidad de Las Palmas de Gran Canaria and Università di Parma (£172k EU funded SAFETY project).

Murray was the UK-PI on a 16-nation collaboration mapping cross-cultural/linguistic language development in children who used technology-mediated ways of communicating.

Serrant developed and published a new theoretical framework for conducting research in the area of work, 'The Silences Framework'. She is collaborating with academics in the Netherlands, Poland and Slovenia on disparities investigating the impact of social inequalities on health and life chances.

Slevin has a productive clinical collaboration with Professor Malik at Weill Cornell Medicine (Qatar) with two co-supervised PhD students working on central and peripheral neurodegeneration in diabetes. Slevin has full Professorial titles at the Universities of Targu Mures (Romania) and Griffith University, Brisbane (Australia). He is visiting Chair in Clinical Biomedicine at the ICC-CCSIC, St Pau Hospital, Barcelona and Adjunct Professor at both Al Majma'ah and Ha'il Universities in Saudi Arabia.

How staff engage with key users and beneficiaries to develop impact

Health Innovation Manchester (HinM): This academic health science and innovation system, formed by merging Greater Manchester (GM) Academic Health Science Network and the Manchester Academic Health Science Centre, plays a pivotal role in bringing forward a constant flow of targeted innovations, and supporting their adoption across GM to transform the health and wellbeing of our 2.8M citizens. HInM houses the new NIHR Applied Research Collaboration (ARC) for GM, established to find new ways of preventing illness, delivering care and supporting professionals to translate this into practice. *Ollier* is on the organising committee; *Jack* is a member of a cross-HEI 'Faculty of Experts' working with HInM to advance integrated care in Tameside.

Manchester Academic Health Science Centre (MAHSC): Closely intertwined with HInM, MAHSC has six research domains, which function across Greater Manchester to translate cutting-edge research into healthcare and industry collaboration for patient benefit. *McKay*, *Correa-Muller*, *White* and *Wilkinson* are on the organising committee for the newly-formed MAHSC neuroscience and cardiovascular domains. AHP academics have received £30k of pump-priming funds through MAHSC calls to develop clinical academic collaborations.

MIDAS: Manchester's inward investment agency has a strategic aim to secure significant levels of new investment and employment for GM. Their services are available to companies of all sizes that wish to relocate to, or expand within, GM. Collaboration and communication with the region's HEIs, including Manchester Metropolitan, is one mechanism.

BioNow: Facilitating network and community bringing early stage Biotech into contact with professional service providers, investors, universities and NHS organisations. They provide a range of specialist services, expert guidance and knowledge-sharing, and focused networking events. Manchester Metropolitan are premium members.

Nuffield Health Partnership: Manchester Metropolitan signed a collaborative agreement with Nuffield Health in October 2018. Nuffield Health is the UK's largest not-for-profit healthcare provider, having 35 hospitals and 111 gyms. We focus on translational research and knowledge exchange in emotional wellbeing and long-term health conditions. This research will also feed into education and workforce development programmes. *Powell* has been appointed as Nuffield Health Chair of Public Health, and *Lee* currently has a fully-funded Nuffield Health PhD studentship. Activities are led strategically by a cross-organisation Partnership Board, which has commissioned three catalyst projects to date. In addition, as a result of the Partnership, Nuffield Health has commissioned additional research projects, including an exploration of the impact of remote working on health and wellbeing with *Powell*. The output from this work was presented to Nuffield's corporate clients in June and November 2019, and in the first three days that it was available it was downloaded over 500 times. Two Knowledge Exchange Partnerships were completed in April 2019 and developed a new service for Nuffield corporate clients, personalising health feedback as part of an individual's health assessment. This work has been presented at two international conferences (*Burns*).

Pennine Care: The partnership aims to ensure the workforce is equipped with the knowledge, skills and qualifications to deliver excellence in primary and secondary care, to drive a progressive improvement in mental health and community wellbeing (*Duxbury* is a board member). Activities in relation to this partnership include: Development of Professional Doctorate Scholarships; MSc Health and Neuropsychology pathway placements; White Rose PhD Scholarship; review of services in Child and Adolescent Mental Health Services; and joint research bids to third party funders (RCN Foundation, Comic Relief).

Wider contributions to economy & society

We have worked with big pharma (Astra Zeneca, Bayer, Smith+Nephew, and Takeda) as well as acting on the scientific boards of many SMEs (Immetacyte, Wide Cells, Microbial Solutions, Intelligent Fabric Solutions, Synthetic Genomics Vaccine Inc. and Lipogems).

Working with the DNA production company, Touchlight Genetics, *McKay* has developed and patented a novel method for producing clinical-grade iPSC. This technology is being further applied to an Innovate UK-funded collaboration with the T-cell immunotherapy provider, Immetacyte, to treat cancer patients with metastatic melanoma.

Wilkinson and *Alexander's* research into Lupus patient cardiovascular risk classification process; QRISK2, showed that a revised QRISK3 methodology was more accurate at detecting patients at high-risk of myocardial infarction (MI). This will result in better interventional management of cardiovascular disease in SLE patients.

McDowell's refinement of troponin C point-of-care testing alongside existing acute MI and heart score algorithms will result in rapid and accurate assessment of suspected MI after presentation at hospital A&E departments. This work is currently being trialled with Dr Rick Body, a Consultant Cardiologist at Manchester University NHS FT.

Murgatroyd and *Ray* (C24) have re-evaluated existing brain MRI scan data of Parkinson's disease patients revealing cholinergic basal forebrain atrophy as an early biomarker for cognitive decline and onset of dementia, a similar neuropathological event to that observed in Alzheimer's disease. This work is being developed with clinical and computing partners as a diagnostic/prognostic biomarker for use in the NHS.

We have excellent ongoing links in both statutory and 3rd sector health provision that inform our approaches and, in turn, have benefited from our research. This includes the appointment of *Powell* to a Chair funded by Nuffield Health. Her research has led to a widely read report produced for Nuffield Health that explores the relationship between remote working, stress, health, wellbeing and productivity. This has been the most successful white paper that Nuffield Health have produced, and the results have been disseminated at corporate events to over 300 businesses.

Duxbury is Chair and Trustee of the national charity: Restraint Reduction Network. Under her leadership, the charity has launched national standards on restraint training at the House of Lords (2019). These are mandatory guidelines to be used in health and social care settings. *Duxbury* has recently been awarded a fellowship with NICE (2020-2023) as an NIHR reviewer for Pre-doctoral Clinical Academic Fellowships, and continuing as a board member of the European Violence in Psychiatry Research Group.

Murray is a founding member of the All-Party Parliamentary Group for Assistive Technology (APPGAT) and has presented her research at Westminster and the Scottish Parliament.

Whitehead works closely with industry partners including: Lubrizol, Ciba Speciality Chemicals, Fothergill Polycorn Millennium Chemicals, Unilever, Eurocell, Sanderson's Bakery, Thor Specialities, and Holchem Laboratories Ltd. The impact from this work has included the implementation of new cleaning procedures, translation of knowledge to new companies to

develop new products, the development towards a new cleaning algorithm, and the incorporation of a biocide to provide antifouling surfaces, with another company.

Slevin is Chair of Kidscan cancer charity and the American Heart/Stroke Association committee for vascular disease.

Public engagement and patient and public involvement

We actively engage with the public, utilising social media (multiple theme-specific Twitter accounts) and partnering in the Manchester Science Festival from its inception, and organise events, providing facilities that address challenging and sensitive topics, such as sexual health (*Lee*) as well as cardiovascular disease and diabetes (*Weston, Wilkinson, Alexander, White and PGRs*). *Pritchett* has organised multiple bioscience workshops and day summer schools at local schools and sports clubs in South Manchester over the past five years. *Verran* has delivered a vast array of events in partnership with professional societies (the Society for General Microbiology and the Society for Applied Microbiology) whose innovations have had an ongoing influence on the engagement practices worldwide (see ICS 2). *Verran* was on the organising committee for the European Science Open Forum's public engagement strand and has delivered interdisciplinary events with computer scientists and gothic writers at Cheltenham Science Festival and *Deadinburgh*. She instigated and led the education strategy for the federation of European Microbiology Societies (FEMS). *Dempsey-Hibbert* ran a well-attended Manchester Research & Awareness event on World Sepsis Day 2019. *Murgatroyd* has led Dementia Café events to bring researchers and those affected by dementia together to discuss current research and awareness.

AHP colleagues receive support for public engagement from the RKE Impact and Engagement team that has helped us to deliver award-winning activity, including the nationally-recognised 'Seven Thousand Feet' project, which won 'Highly Commended' in the QiC Diabetes awards category: 'Diabetes Collaboration Initiative of the year – Adults' section (*Wilkinson and Weston* contributed). We have an annual public engagement award, which provides a small amount of resource for activities. This has previously been won by *Wilkinson, Pritchett, Edwards, Coulthwaite and Hidalgo*.

Cordero and Powell have run a series of health behaviour change events in art galleries and museums, shopping centres and Manchester Town Hall (2016-2018) for health professionals and the public, attracting audiences totalling over 5,500. Their 'Brain Box Science' event at Manchester Town Hall, (with Manchester and Salford Universities and Manchester City Council) involved the Museum of Science and Industry, the NHS Trust, patient groups and artists (June 2016). The event attracted over 5,000 people of all ages and received exceptional feedback from the public. A large proportion of AHP staff and PGRs have organised 'SciBar', a 'Pint of Science' and BHF Heart Experience events. *Weston* is on the judging panel for UK Heart Safe Awards and *Unsworth* has represented women in science and young investigators at various national public engagement fora through her committee role with the Platelet Society.

Murray has a long research history of centralising PPI in her clinical, educational and research endeavours. This was acknowledged in her appointment as a fellow of the Royal College of Speech & Language Therapists in 2017. She was awarded additional funding in 2018 specifically to evaluate the impact and influence of PPI/PCIE on the delivery of a funded research programme. The conclusions from this evaluation demonstrated that those living with complex speech and motor disorders (often regarded as hard-to-reach or include in PPI/PCIE activities) can be included.

In collaboration with Batten Disease Family Association (BDFA), *McKay* ran an open day for families of children with Batten disease to show them the research facilities at Manchester Metropolitan and describe the ongoing research to find new therapies for Batten disease. The event in 2018 was attended by over 30 Batten family members and four BDFA partners as well as ten researchers and support staff. The day was a success for families and researchers alike and we planned another event for 2020 that was postponed due to COVID-19.

Our ICS features the many ways in which we have reached vulnerable users, including *Sutcliffe's* research on novel psychoactive substances (see ICS 3), which describes how he has used his techniques for testing the chemical make-up of substances at festivals, such as Manchester Pride, to protect people at risk of harm from dangerous substances. The Manchester Drug Research and Knowledge Exchange (MANDRAKE) facility is part-funded by GMCA and is being formally integrated into Greater Manchester Police response procedures for critical incidents where drugs are thought to be involved.

Contribution to the discipline and indicators of influence

We are proud to have Fellows of many esteemed national and international societies, including the Royal College of Speech and Language Therapists (*Goldbart, Murray and Sage*), the Royal Society of Rheumatology (*Ollier*), the Royal Society of Pathologists, the American Heart and Stroke Association, the Institute of Biomedical Scientists UK (*Slevin*), the Royal Society of Biology (*van der Gast*), and NICE (*Duxbury*). We have four staff who are members of the Royal College of Nursing and *Serrant* is a member of the Queen's Nursing Institute, an appointed commissioner for the Department of Health, and Chair of the Chief Nursing Officer for England's BME Strategic Advisory Group.

Scientific and healthcare conferences are a primary route of research dissemination and developing collaborations. Our staff have shown a prolonged commitment to the organisation of conferences and have been active members of the organising committees of 13 international conferences during the assessment period, such as the European Council for Cardiovascular Research Conference, the European Nanomedicine Conference and the British Society for Gene and Cell Therapy conference.

We have staff on professional associations and organisations, including *Murray* who is a committee member and former chair of the International Society for Augmentative and Alternative Communication, *Alexander* who has served as chair of the European Vascular Biology Organisation (EVBO) and the British Society of Cardiovascular Research (BSCR), *Azzawi* who is a trustee of the British Society for Nanomedicine and BSCR committee member, *Bergqvist* who is elected Secretary of the World Psychiatric Association Section for Philosophy & Humanities in Psychiatry, *Wilkinson* who is an EVBO council member, *Unsworth* and *Jones* who have organising committee and steering committee roles with the UK Platelet Society, and *Duxbury* who is a board member of the European Violence in Psychiatry Research Group. *Fatoye* served on the Advisory Board on Chronic Wound Management – Urgo Medical, 2017; the Advisory Board Real World Evidence Astellas Pharma (2015 to 2018); is a member of the Scientific Committee International Health Economics Association (iHEA) World Congress; and a member of the Scientific Committee, International Society for Pharmacoeconomics and Outcomes Research (ISPOR), North American and European Congresses. *French* is the Early Psychosis Lead for Cheshire and Mersey STP and is on the National Expert Reference Group for Early Intervention in Psychosis. *Goldbart* is a member of Mencap's External Advisory Forum and a Council member of the International Society for the Scientific Study of Intellectual and Developmental Disabilities.

We have representatives on funding committees, such as NC3Rs (*White*), BBSRC (*Correa-Muller*), UKRI-2019, Innovate UK, EPSRC, and NERC (*van der Gast*), NIHR (*Duxbury, Fatoye, French and Serrant*), EU Horizon 2020 (*Enright and Whitehead*) Innovative Medicines Initiative panel, Arthritis Research UK Osteoarthritis, Crystal Diseases Clinical Studies Group and Heart Research UK. Chartered Society of Physiotherapy Scientific Committee (*Goodwin, Yeowell*). Colleagues have represented Manchester Metropolitan on international peer review panels in Belgium (*Goldbart*) and Poland (*Benn*).

Our academics hold visiting, honorary, emeritus or extraordinary positions at national (Universities of Salford, Manchester and Warwick, and the NERC Centre for Ecology & Hydrology), and international (Weifang University, China; Great Lakes University of Kisumu, Kenya; University of Ibadan; Nigeria University of KwaZulu-Natal, University of Pretoria, South Africa; and Satakunta University of Applied Sciences, Pori, Finland) higher education institutes. We also have academics

that hold Honorary non-clinical roles within NHS Foundation Trusts including *van der Gast* within the Northern Care Alliance NHS Group.

We have represented the University at key international conferences, including the South Africa Speech-Language-Hearing Association, Durban, South Africa (2019); East African Communication Disability Conference, Kisumu, Kenya (2019) (*Marshall*). *Fatoye* was keynote speaker at the European World Congress of Physical Therapy (2017) and the Nigerian Society of Physiotherapy, Lokoja (2015). *Goldbart* was keynote speaker at the EACD Summer School for ECRs, University of Pisa, 2019; International Symposium 'Creating Better Life Quality for People with PIMD/CISN', Plovdiv, Bulgaria, 2019; and the 4th International Scientific and Practical Conference: Augmentative and Alternative Communication, St Petersburg, Russia, 2019. *Webb* was invited as keynote speaker at the Society for the Study of Addiction - symposium chair, 2018.

Our staff are editors and associate editors on leading journals. *Fatoye* is associate editor for BMC Musculoskeletal Disorders; *Goldbart* is Associate Editor for Augmentative and Alternative Communication Journal; Journal of Intellectual Disability Research; International Journal of Disability Development and Education, and British Journal of Learning Disabilities. *Goodwin* was Associate Editor BMC Health Services Research. *Webb* is on the editorial board for the Journal of Substance Use, and the Journal of Psychiatric and Mental Health Nursing. *Whitehead* is a Subject Editor for the Food Bioproducts Processing Journal.

Our students and staff are prize winners: *Edwards*, PDRA with *Wilkinson*, who won the Aletta Jacobs Memorial Award at the German Society for Microcirculation and Vascular Biology in 2021. This award is dedicated to promoting female scientists in the field of microvascular biology at the start of their career. *Duxbury* was awarded the Eileen Skellern award for Mental Health Nursing in 2014 and an OBE for services to mental health in 2020. *Verran* won the American Association for the Advancement of Science award for public engagement with science in 2019. *Serrant* was awarded an OBE for services to community nursing. *Murray* won research project of the year at the national AAC awards.