

Institution: The University of Nottingham

Unit of Assessment: 03 Allied Health Professions, Dentistry, Nursing and Pharmacy

1. Unit context and structure, research and impact strategy

The **Discovery to Society** research strategy of allied health professions, nursing and pharmacy at Nottingham delivers innovative world-changing health research in a first-class physical and digital environment, making a positive impact on the health and wellbeing of individuals and populations. Cross fertilization and interdisciplinary research throughout our ten distinct but complementary research themes result in a diversity of approaches to developing treatments and interventions for some of the most important challenges in healthcare. Over the REF period our success of delivering this strategy has been founded on an inclusive culture with significant investments in people, facilities and research structures, with our:

- Discovery and characterization, made through development and application of new experimental approaches (e.g. bioluminescence/fluorescence resonance energy transfer; high-throughput high-content materials characterization), of new drugs and their targets to address global healthcare challenges (e.g. novel action macrocyclic antibiotics; selective β_1 -adrenoreceptor antagonists for cardiovascular and respiratory disease; inhibitors of the integrated stress response in neurodegenerative disease).
- Direct influence on health policy and shaping of national and international guidelines (e.g. informing the transformation of community pharmacy to deliver vaccinations; nationally-adopted policies for falls and accident prevention; interventions significantly reducing prescribing errors; leading regional and national service improvements in rehabilitation delivery; underpinning of the adoption of medicines services saving the NHS over £500M).
- Engagement with industry and commerce to maximize the impact of our research on the health of society (e.g. translation to market of a new class of bacteria-resistant catheters using our new materials; enabling a billion-dollar petrochemical company to reduce gasoline's environmental and health impact).
- Creation of a rich and vibrant research environment, including the creation of the Biodiscovery Institute through a £23M investment and expansion of the Centre of Biomolecular Sciences, and the establishment of the £24M NIHR Nottingham Biomedical Research Centre in partnership with Nottingham University Hospitals NHS Trust.
- Investment in people, such as our establishment of prestigious joint 4-year UoN/MIT Research Fellowships in AI-Biomaterials Discovery, recruitment of 33 research-active academic staff (including 12 ECRs), and 38 [†]promotions.
- Significant expansion of research activities in audiology and rehabilitation, and definition of new research fields (e.g. electroceutics, astropharmacy (with NASA), on-site on-demand personalized pharmaceutical manufacturing).
- Recognition with a Global Top 10 position in the QS World University Rankings (Pharmacy and Pharmacology) throughout the REF period.

1.1 Our Research Strategy

Building on the foundation of the UoN's *Research Vision*, the research strategy of our Schools of Pharmacy (SoP: 55.4 FTE; 57 category A staff), Health Sciences (SoHS: 26.0 FTE; 29 staff) and Medicine (SoM: 17.3 FTE; 19 staff) is tailored to their distinct discipline-related research challenges to collectively develop treatments, therapies and interventions to address complex challenges in healthcare ('**Discovery to Society**'). We have built on our strong research base with new research structures centred on excellence at all levels, supported by targeted School and University resources, and complemented by a global network of leading academic, health service, government and industrial collaborations. Since REF2014, our principal strategic theme is the firm commitment to sustaining inclusive world-leading research, achieved through a number of actions: research pipeline management, capacity and capability building, research

student recruitment, career support and growth, development of infrastructure to create impact. The aligned research strategies of our Schools contain a focus on, and investment in:

- **Interdisciplinary research:** We will continue to work across multiple subject boundaries. Delivery of our research strategy is facilitated by our engagement in the UoN's transdisciplinary Beacons of Excellence [REF5a-2.1b] (providing analytical expertise and resource to the *Green Chemicals* Beacon; establishing the Survivors and Cultures Programme of the *Rights Lab*), eight of the Interdisciplinary Research Clusters (IRC) (including *Crawford* leading *Health Humanities*) [REF5a-2.1b], investment in infrastructure, and sandpits, workshops and targeted School and external funding (e.g. EPSRC '*Bridging the Gaps*' C Alexander with UoA1, 5, 6, 8, 9, 10, 11, 12). We are core members of the Biodiscovery Institute – the UoN's flagship research institute, expanded in 2019 through a £23M University investment, spanning our two faculties. Our multidisciplinary working is reflected by over 40% of our outputs in this period categorized by SciVal as research in 'arts & humanities', 'chemical engineering', 'computer science', 'engineering', 'environmental science', 'materials science', 'mathematics', 'multidisciplinary', and 'physics & astronomy'. With co-applicants from 22 UoAs across the Institution we have been awarded research funding of over £175M.
- **Capability and capacity:** During the REF period we undertook significant reorganization and created new structures to build on the Biomedical Research Centre (BRC), EPSRC programme grants, the renewal of the UK Regenerative Medicine Platform, and opportunities to expand research in hearing sciences to realize our **Discovery to Society** research strategy. The formation of the BRC in partnership with the Nottingham Universities Hospital Trust enabled a translational focus for our research in musculoskeletal disease, hearing, and digital interventions for mental health (£24M NIHR). We further expanded our hearing sciences research by bringing researchers from the MRC Institute of Hearing Research together with those funded by the BRC Hearing theme. We introduced a new research structure in SoP to cross-fertilize new approaches to identify and tackle challenges in healthcare resulting in five new research divisions with deliberate overlap in activities fostering transdisciplinary research. Through targeted recruitment we expanded our research in the areas of psychology of health and wellbeing, health economics, and children and young people's healthcare. Longer term succession and new positions are planned in biomaterials, artificial intelligence, and enabling pharmaceutical healthcare in resource-limited and extreme environments.
- **People:** With inclusivity and by embracing diversity, we continue to support career development, foster leadership and realize personal and collective ambition. Implementation of our strategy, facilitated by the reorganization of our research structure, is underpinned by strategic staff appointments in areas designed to build capacity in biomaterials discovery and analysis, bioelectronics, biomedical engineering, dementia, international pharmacy and traditional medicines, mental health and rehabilitation, children and young people, and maternal health and wellbeing. We have made 33 appointments, including 12 Early Career Researchers (ECRs), and will continue to recruit and nurture research leaders through the UoN's Anne McLaren and Nottingham Research Fellowship schemes [REF5a-3.2] and support them to become research leaders. We will also recruit existing outstanding research leaders at associate professorial and professorial level (Section 2). We have supported (>£300k) seven staff for secondment and study leave (e.g. *Dreveny*[†], *Hui*[†], *Tanner*^{*}) and such activities have directly led to new collaborations (e.g. NASA), research projects (e.g. *De Moor*, £558k BBSRC) and outputs (e.g. *Blood*, *Nucleic Acids Res.*). We remain firmly committed to Athena Swan and promote gender and race equality and representation, progression and success for all. In addition to UoN's Silver Award, our three individual Schools hold Silver Awards.
- **Collaboration and Internationalization:** We will continue to extend further our interdisciplinary research through collaborations with academic and industrial partners across the UK and abroad. We lead and participate in major national UKRI and NIHR funded research programmes, e.g. regenerative medicine, vaccine manufacture, recovery from mental health and stroke (Section 3). We are key members of the Institute of Mental Health

(IMH) partnership between the Nottinghamshire Healthcare NHS Foundation Trust and the University. International collaboration forms a key part of our research and impact strategies, supported by both School and Institutional funds [REF5a-4.1] (Section 4). For example, we recently invested £800k to create four-year research fellowships in Artificial Intelligence and Biomaterials with our strategic partners at the Massachusetts Institute of Technology (MIT). Over 42% of our outputs published within the REF period are with international collaborators. We have established the position of Director of International Partnerships to maintain our existing relationships, such as the appointments of the UoN/MIT AI-Biomaterials Fellows, and to identify and develop new strategic collaborations.

- **Impact:** We will continue to ensure that our research has demonstrable impact in a range of diverse areas. Our strategy for creating and making impact, linked to the University's Knowledge Exchange Framework, has been highly productive with beneficiaries related to healthcare (patients, medical charities, drug companies, SMEs), practice (government and professional bodies, nurses, midwives, allied health professionals, audiologists, doctors, pharmacists) and wider society (teachers, pupils, general public). Staff are encouraged to identify and develop impact by Champions in each of the research areas, and supported by School and Faculty, the UoN Nottingham Impact Accelerator, and external funding and support mechanisms such as the Midlands Innovation and Commercialisation of Research Accelerator (MICRA) (e.g. EPSRC IAA awards to: *M Alexander, Allen[†], Chauhan^{*}, Dixon[†], Hooke[†], Mantovani[†], Rose[†]*; ESRC IAA awards to: *Blake[†], Goldberg[†], Wharrad*; UoN HERMES scheme (HEIF) awards to: *Chan[†], Chauhan^{*}, Coulson[†], Hooke[†], Laughton[†], Mata^{*}, Parmenter[†], Scurr*; MICRA award to: *Chauhan^{*}*; MRC CiC awards to: *Bradshaw, Chan[†], Dixon[†], Gershkovich[†], C Roberts*; Institution awards to: *Logan, Spiby, Goldberg, Walker*; UK Space Agency Industry Placement: *Toh^{*}*).

1.2 Translation and Impact

We will continue to translate our research through research partnerships (facilitated through the BRC and IMH), funding, and commercialization opportunities. For example, *Chan[†]* leads a multi-disciplinary team with *Dreveny[†]*, the BRC, our Advanced Data Analysis Centre, and the London School of Hygiene and Tropic Medicine undertaking the translational development of a novel macrocyclic antibiotic for treating *Clostridioides difficile* infection (£1.7M MRC DPFS); *Shakesheff* and Locate Therapeutics received Innovate UK funding to adapt the *TARgeted ORchestrated Signalling* (TAOS) matrix system for use in administering therapeutic cells; our spin-out Molecular Profiles (*Davies, C Roberts, Williams*) was purchased by Columbia Laboratories Inc. for \$25M in September 2013 with retention of University interest. Renamed Juniper Pharmaceuticals the company employs 150FTE locally, and was sold to Catalent for \$130M in 2018.

Our IP is protected via invention disclosures, mostly in the form of patent applications. Regular consultation with staff allows potential disclosures to be considered by the Schools' research and knowledge transfer committees and refined by the academic team prior to consideration by the University's Research and Innovation team. Our active IP portfolio includes 104 patent filings in 26 families of which to date 77 have been granted. Since 2014, we have made 79 new internal IP disclosures and filed 20 new patent families, and signed 10 licensing and assignment deals with commercialization partners. Our eight UoA3 impact case studies have been selected from a wider portfolio of activity and demonstrate our researcher-led interdisciplinary (with UoA2, 5, 12 and 17) and industrial and user collaborative approach to impact.

Our strategy for impact is reviewed on a rolling basis to ensure it is fit for purpose, with short-, medium- and longer-term targets and priorities:

- In the short term we are investing in new posts in partnership with end users to grow research with new opportunities for impact. In 2018, we established the Laboratory-to-Clinic Translational Research in Cancer with the appointment of one professor (*Needham^{*}*) and two postdoctoral researchers through the University's Strategic Development Fund (£474k) as a coordinated cross-divisional, cross-faculty and cross-institution activity (with Duke University and the Southern University of Denmark) to deliver an Investigational New Drug Application

for an anticancer therapeutic (*Mol. Cancer Ther.*). We will continue to utilize the new Nottingham Reward Scheme to recognize and reward activities above and beyond staff roles.

- In the medium term we will continue to engage new members of staff and research students in our impact activities to secure KT funding (e.g. Knowledge Transfer Partnerships of *Scurr* with Boots; C Moffatt with Smith & Nephew; *Rose*[†] with The Electrospinning Company Ltd; three of *Aylott*[†] with TBG Solutions and SureScreen Diagnostics), and work collaboratively across NUH and UoN to drive impact from clinical academic research (e.g. *Coad*^{*}). Staff are supported in undertaking external roles (local and national committees, consultancy, board or advisory group membership – Section 4) via a workload planning model that takes account of teaching, administration, research, and external activities with up to 20% of time spent on external engagement (e.g. *Stocks*[†] supporting KalVista with US Patent 9533987 and their \$760M partnership deal with Merck). A Research Impact Showcase is included in our Postgraduate Allied Health Conference (covering research impact, research skills and methods, careers, EDI, wellbeing and welfare. 2019: 123 delegates), impact training occurs in Researcher Academy provisions for PGR students, and in our internal divisional and School seminars. We will continue the policy of match-funding many joint industrial PhD studentships.
- Longer term as we establish new national and international strategic research links with institutions and industries, we aim to broaden our impact by building on synergism in the collaborations. We foresee increased impact through greater exploitation of the research base at our campuses in Malaysia and China, and of our strategic partners at China Pharmaceuticals University, La Trobe, MIT, National University of Singapore, Seoul National University, Tianjin University of Traditional Chinese Medicine, and University of Melbourne.

1.3 Our Achievements and Future Research

To deliver our Discovery to Society research strategy, we work collaboratively within ten distinct but complementary research themes across our schools and faculties (Medicine and Health Sciences SoHS, SoM; Science SoP). For each of the ten themes we describe below their rationale and core strengths, provide some research highlights from 2014 onwards, and indicate specific future research strategy in these areas (Category A staff and £M awarded to the Unit):

- ***Biomolecular Science and Medicinal Chemistry*** (BSMC) (SoP: 14 £8.6M): We aim to characterise and understand new disease-relevant biological processes leading to the discovery of biologically active compounds through integration of macromolecular structure, chemical biology, computational chemistry and drug discovery. We have strengths in synthetic (e.g. MRC Fischer) and computational (e.g. EPSRC *Laughton*[†]) chemistry and structural (e.g. BHF *Emsley*) and functional (e.g. MRC *Winkler*) biology applied to molecular recognition and the design of new therapeutics (e.g. MRC *Kellam*). Achievements over the REF period include the discovery of antibacterial drugs for gram-positive and gram-negative bacteria (*J. Bacteriology*, *J. Med. Chem.*, *Molecules*); development and use of fluorescence correlation spectroscopy to study GPCR function in membrane micro domains of single living cells (*J. Med. Chem.*, *Science*); structural identification of the ubiquitin specific protease family of deubiquitinating enzymes USP15 and USP11 (*J. Bio. Chem.*); first-in-class selective β_1 -adrenoreceptor antagonists for concomitant cardiovascular and respiratory disease (*J. Med. Chem.*)

Our future strategy will focus on the discovery and understanding of new targets aided by our continued development of fluorescence and bioluminescence technology with the recent appointment of *Kilpatrick*^{*} and the driving of interdisciplinary research through the *End-to-End Therapeutics* IRC, established in 2019, that we co-lead (*Kellam*) [REF5a-2.1b].

- ***Molecular Therapeutics and Formulation*** (MTF) (SoP: 13 £7.2M): We perform leading research into new drugs, emerging therapeutic targets, and the materials and processes which turn these drugs into medicines. Particular strengths include the synthesis of new materials (e.g. EPSRC *C Alexander*) to deliver drugs to target sites, biophysical characterisation of complex drugs and formulations (e.g. Innovate UK *Burley*), investigation of gene regulation (e.g. BBSRC *Jopling*[†]) and immunological processes in cancers,

neurodegenerative disorders and inflammatory diseases, and mechanistic analysis of drugs and formulations to treat these pathologies (e.g. EPSRC *Stolnik*[†]). Achievements over the REF period include the characterisation of circadian clock components which regulate flavivirus replication (*Nat. Commun.*); structure of the *Helicobacter pylori* adhesin BabA. (*Sci. Adv.*); self-selective labelling of bacteria by *in situ* polymerisation (*Nat. Mater.*).

Our future strategy will centre on enabling the effective delivery of therapeutics in new areas and situations, such as those in extreme environments. This will include our lead of Astropharmacy (NASA *Williams*) and the appointment of an Assistant Professor in 2021, with impact in environmental and population health and sustainability, through continued collaborations with UoA1, 4, 5, 6, 8, 9, 10, 11, 12, 14 and 21.

- **Regenerative Medicine and Cellular Therapies** (RMCT) (SoP: 10 £9.2M): Our mission is to transform basic scientific research at the interface of biomaterials discovery and development, nanotechnology, bioengineering and stem cell research into disruptive technologies for regenerative medicine. Our strengths include the development of biomaterials and biointerfaces to control cell behaviour (e.g. Leverhulme *Zelzer*[†]), controlled release of bioactives to stimulate tissue repair (e.g. EPSRC *Rose*[†]), 3D bioprinting (e.g. EPSRC *Yang*) and cell patterning (e.g. EPSRC *Buttery*) technologies to fabricate tissue-relevant structures (e.g. H2020 *Mata*^{*}), non-viral delivery of biomolecules to control tissue regeneration (e.g. CFF *Dixon*[†]), and electrochemical nano-systems to modulate cell behaviour (e.g. EPSRC *Rawson*[†]). Achievements over the REF period include the development of an array of scaffolds, hydrogels (*Adv. Funct. Mater.*) and microparticles with controlled size, shape, release profile and topography (*ACS Appl. Mater. Interfaces*). We have developed materials that are stimuli responsive, self-assemble into hierarchical structures (*Nat. Commun.*) and have functional biointerfaces (*Chem. Commun.*). We have developed electrochemical nano-systems (*Adv. Funct. Mater.*) and non-viral delivery systems for the delivery of DNA, mRNA and proteins to control tissue regeneration (*PNAS*).

Our future strategy focusses on the establishment of a Centre for Additive BioFabrication, with the joint appointment of *Mata*^{*} with Engineering, to provide *in vitro* models for drug and toxicity screening that can accurately guide the development of new medicines, to generate functional cell-based clinical therapies, and to recreate biological ecosystems that can develop our understanding of the impact of environmental change. This is a strategic focus of UoN with the establishment in 2019 of the Interdisciplinary Research Cluster in *Additive BioFabrication* [REF5a-2.1b].

- **Hearing Sciences** (SoM: 6 £5.1M): Our mission extends from discovery to health and policy impact while maximising opportunities for interdisciplinary research and translation. We specialize in studying behavioural aspects of hearing disability and understanding how natural and chemotherapy-induced hearing loss affects real-life behaviour (e.g. Action on Hearing Loss (RNID) *Baguley*). We develop novel strategies (e.g. NIHR *Henshaw*) and tools (e.g. MRC *Wiggins*) for the recognition and integration of hearing healthcare into clinical practise to maximise quality of life (e.g. H2020 *Naylor*[†]). Achievements over the REF period include our systematic review identifying new genetic vulnerability and resilience to cisplatin ototoxicity (*JAMA Otolaryngol. Head Neck Surg.*); establishing a conceptual structure for understanding cognitive aspects of hearing difficulty (*Ear & Hearing*); discovering the links between ageing well and hearing well through the application of cutting-edge imaging and informatics technique (*PNAS*); developing frameworks for the rigorous evaluation of interventions and self-management strategies for tinnitus and hyperacusis in children and adults (*Hearing Res.*)

Our future strategy is to build on our strengths in evidence-based patient-partnership research to advance the diagnosis, treatment, and management of hearing and tinnitus problems. We will conduct auditory ecology and translational research to optimize provision, uptake and benefit from devices and interventions, and exploit opportunities in health informatics to develop diagnostic, pheno-/geno-typing tools and emerging therapeutics to enable personalized treatments.

- **Advanced Materials and Healthcare Technologies (AMHT)** (SoP: 14 £13.0M): We work to address unmet healthcare needs through the discovery, development and manufacture of new materials (e.g. EPSRC *M Alexander*) and diagnostics (e.g. EPSRC *Aylott*[†]) and the application of state-of-the-art analytical (e.g. BBSRC *Kim*[†]) and measurement science (e.g. EPSRC *Scurr*). Research is undertaken into fundamental and applied biomolecular (e.g. BBSRC Barrett), biomaterial and formulation problems at the nano and micro scale (e.g. StoneyGate *Marlow*). Achievements over the REF period include the establishment and execution of an innovative programme of high throughput materials discovery research through which we developed new materials with improved anti-bacterial-adherent properties resulting in the market launch of the Camstent urinary catheter (*Adv. Mater.* [ICS-1 *M Alexander*]); the development and deployment in academia of the world's first 3D OrbiSIMS time-of-flight secondary ion mass spectrometer (*Nat. Methods*; *Nat. Commun.*); the first ink-jet printing of pharmaceutical tablets (*Int. J. Pharm.*).

Our future strategy is to take an analysis-led, data-driven approach to our core expertise in discovering new materials, understanding pharmaceutical formulations and developing new diagnostic and manufacturing technologies. We will support our cohort of Nottingham Research fellows and UoN/MIT AI-Biomaterials Fellows to become research leaders in materials and healthcare technologies. We will have a focus on the translation of our research with our industrial partners to address the arising needs in personalised healthcare.

- **Rehabilitation Research** (SoM: 7 SoHS: 6 £11.7M): Our mission is to reduce the effects of illness and disability, helping people to lead fulfilling lives, including returning to work, and to design and evaluate interventions to support recovery. We draw on expertise from allied health professions, nursing, psychology, and medicine with significant grant income for research in stroke (NIHR HTA trials: *Radford, Thomas*[†], *Drummond*); vocational rehabilitation (NIHR PGfAR: *Radford*), cognitive rehabilitation (NIHR RfPB & NIHR HTA: *Walker, Thomas*[†], *Drummond*), and implementation of complex interventions (NIHR HS&DR: *Fisher*[†]). Achievements over the REF period include securing over £6M in NIHR funding for international trials, implementation and health economic research, and the formation of the £9M NIHR Applied Research Collaboration East Midlands. Our outputs include co-careldopa as an add-on therapy to occupational and physical therapy in patients after stroke (*Lancet*); family-led rehabilitation after stroke in India (*Lancet*); occupational therapy in care homes (HTA 2016); memory rehabilitation for people with traumatic brain injuries (HTA 2019); transforming community-based rehabilitation for stroke survivors [ICS-2 *Fisher*[†]].

Our future strategy is to rigorously evaluate interventions that aim to improve the lives of patients affected by disability and illness and implement our findings in real world settings. This will be enhanced by our leadership (*Radford, Logan*) of the National Rehabilitation Centre (part of the Defence and National Rehabilitation Centre Programme), which will transform specialist rehabilitation services in the East Midlands.

- **Mental Health** (SoHS: 6 SoM: 2 £2.5M): Our mission is to help make mental health services more recovery-orientated and better able to promote wellbeing. Our interdisciplinary strengths are in mixed-methods research, theory development, systematic reviews, first-in-field trials, psychological/digital intervention trials, generation of policy-relevant evidence, international networks, and collaborations. We co-lead the £3.6M 'Digital Interventions for Mental Health' BRC sub-theme that aims to develop the next generation of transformative mental health technologies. We lead projects with total value over £8M in recovery (NIHR PGfAR *Slade*^{*}, EU Commission *Slade*^{*}), and health humanities (AHRC, *Crawford*). Achievements over the REF period include leading on a project with industrial partners Aardman Animation Ltd to create a series of short animations on mental health for young people. Our outputs include supporting recovery in patients with psychosis using mental health teams (*Lancet Psychiatry*) and recovery-oriented practice training for specialist mental health care staff (*Lancet Psychiatry*).

Our future strategy is to develop world-leading research programmes around citizen science and mass participation (planned next BRC sub-theme), Recovery Colleges (£3.5m NIHR PGfAR 2020-2025, *Slade*^{*}) and global mental health (building on current H2020 and GCRF

funding of research in India, Tanzania and Uganda), and to develop a spin-out company for artificial intelligence-based NEON (Narrative Experiences Online) recovery from mental ill-health intervention. We will lead research on the mental health recovery of survivors of modern slavery collaborating with the *Rights Lab* Beacon of Excellence.

- **Pharmacy Practice and Policy (PPP)** (SoP: 6 £1.7M): We influence health policy to improve the safety, efficacy and efficiency of medicines use (e.g. HEE *Knaggs*), and global pharmacy education and workforce policy (e.g. Schlumberger Foundation *Anderson*). We have particular strengths in the advancement of knowledge about medicines and their use and in the pharmacist's role in improving public health (e.g. NIHR *Boyd*[†]). Achievements over the REF period include the evaluation of the Community Pharmacy New Medicine Service, leading to its wide-spread adoption, saving the NHS a projected £558 million [ICS-3 *Boyd*[†]]; our research in opioid use and safety (*Int. J. Drug Policy*), our evidence that access to influenza vaccination by at-risk groups is significantly increased through community pharmacy [ICS-4 *Anderson*]; and implementation of our pharmacist-led IT-based intervention significantly reduces clinically important prescribing errors in general practice [ICS-5 *Boyd*[†]].

Our future strategy focusses on understanding and evidencing the development of effective pharmaceutical interventions to improve health outcomes for patients, in particular our continued lead with UoA2 in defining and maximizing the role of the pharmacist throughout the rapidly developing NHS Primary Care Networks in England.

- **Health Across the Life Course** (SoHS: 14 SoM: 4 £14.8M): Our mission is to enhance the health, wellbeing and quality of life of people at key, often transitory, stages of life. Our expertise is in applied clinical research of highly complex problems in multidisciplinary settings. We have close links with the Centre for Evidence Based Healthcare (*Evans*[†]) and have been commissioned to develop guidance for public bodies. We are key members of the BRC, where we lead the 'Complex Packages' strand of the Musculoskeletal Conditions Theme. We played a pivotal role in the development of the Birmingham/Nottingham MRC/ARUK Centre for Musculoskeletal Research (CMAR) that provides a translational research pathway for the findings of the CMAR into applied clinical research. We have been awarded significant grant income for research in midwifery and maternity (NIHR HS&R *Spiby*), preventing obesity in teenagers (EU Commission, *Coulson*[†]), dementia (NIHR PGfAR, NIHR HS&DR *Harwood*[†], *Goldberg*[†], *Gladman*, *Logan*, *Pollock*[†]), reducing the risk of falls in older people (NIHR HTA *Logan*, *Gladman*) [ICS-6 *Logan*] and end-of-life care (NIHR HS&DR, *Pollock*[†]). Achievements over the period include revealing maternal and neonatal consequences of treated and untreated asymptomatic bacteriuria in pregnancy (*Lancet Infectious Diseases*); specifications and interventions to reduce childhood injury [ICS-7 *Watson*]; how online communities of people with long term conditions function and evolve (*JMIR*); medical Crises in Older People (*PGfAR* 2014); and the Getting Out the House study (*HTA*, 2014).

Our future strategy includes building on our existing relationship with the NHS to secure NIHR and charity fellowships for talented clinical academics, and to increase the impact of our research. We will identify and take rapid advantage of new developments in the basic sciences and translate these into clinical practice through the BRC. We will rigorously evaluate complex interventions aimed at addressing the most challenging problems in healthcare.

- **Digital Innovations in Healthcare and Education (DICE)** (SoHS: 3 £1.6M): This theme cuts across many specialities as the aim is to address the need to apply theoretical principles and pedagogy to the design of digital materials used in healthcare interventions. We work with patients, carers and health professionals to co-design digital health interventions to promote behaviour change for health and well-being, to support patients in the self-management of chronic conditions, and in advancing the continuing professional development of healthcare workers. Ensuring flexible and easy access to digital resources is a key feature of our work, which focuses on the concept of the reusable learning object as a model to produce transferable and open resources for global impact in healthcare contexts. Achievements over the REF period include our ASPIRE co-design methodology for creating effective digital

learning tools; our 'Designing eLearning for Health' MOOC that led to further global capacity building projects in digital health in low- and middle-income countries (e.g. EU Commission EACEA *Wharrad, Konstandinidis*[†]); and digital tools for self-management of chronic conditions (e.g. NIHR RfPB *Blake*[†], NIHR RfPB *Wharrad*). Our research has resulted in the production of over 200 open learning resources for health which have been accessed by five million global users [ICS-8 *Wharrad*] and an open digital mental health support package for health and care workers developed in response to the COVID-19 pandemic that by July had been accessed over 41,000 times.

Our future strategy is, in collaboration with health services researchers, to use our co-design methodologies with the next generation of digital technologies, including AI, virtual reality and 360-degree imagery to produce effective digital interventions for the education of patients, their carers and healthcare professionals.

1.4 Dissemination and Open Research

Dissemination, translation and impact of research remain key performance indicators with an emphasis on the quality of output and assurance of research integrity and ethical behaviour. Since 2014, we have published over 2,400 peer-reviewed papers (receiving >30,000 citations and cited in 97 patents), and received over 65,000 citations to our full-body of work, including in 326 published patents.

We are committed to open access publication, open research data and open science [REF5a-2.3]. Researchers make research outputs open access and deposit them in the University repository. The University supports a mixed Green and Gold model of open access publication. We have agreements with major publishers to fully/partially waive article processing charges. Where necessary Gold open access is supported through ring-fenced School funds, allowing staff and PhD students without eligible funding to publish in the most appropriate journals. Preprints are deposited in subject repositories such as bioRxiv, and data, code, scripts and supplementary materials from published outputs in repositories such as RADAR and github, in addition to the University Research Data Management Repository [REF5a-4.2]. All PhD theses are deposited, and 18 of these, deposited in the REF period, have been downloaded more than 500 times. Our unique evidence-based digital learning tools are released for non-commercial reuse with a Creative Commons licence [ICS-8].

1.5 Research related to COVID-19

Our proactive response to COVID-19 includes pandemic subject expertise (e.g. *Spiby, Slade*[†], *Crawford*), exploration of psychosocial behaviours related to COVID-19 (*Coulson*[†]), impactful COVID-19 mental health interventions (e.g. NHS COVID-Well Supported Wellbeing Centres Apr-July: 14,934 facility visits *Blake*[†]), and its impact on hearing and tinnitus (*Baguley, Naylor*[†]). *Pollock*[†] worked with colleagues in Cambridge on the prescribing and use of anticipatory medicines in response to COVID-19 (*BMJ Supportive and Palliative Care*). Working collaboratively with the BRC, our behavioural research funded by UoN's COVID-19 Recovery Board and the MRC aligned with the UoN's pilot asymptomatic SARS-CoV-2 pooled PCR testing (*Blake*[†]), and informed operations and strategy for the wider rollout of PCR testing via the Biodiscovery Institute. As Mental Health Lead at the *Rights Lab*, *Wright* secured UKRI funding in July for COVID-19 Impact and Mitigations for Modern Slavery Victims and Survivors. Through UKRI Rapid Response funding *C & M Alexander* and colleagues in UoA5 will research the use of novel materials for the prevention of virus transmission (*Matter* 2020).

1.6 Policy and Practice of Research Governance

The UoN Code of Research Conduct and Research Ethics provides a framework for the governance of research throughout UoN, requiring adherence to the highest standards of performance and ethical conduct [REF5a-2.4]: It provides specific guidance on areas such as data, publications, intellectual property, ethical review. All Schools have a Research Ethics Officer who provides advice, and manage and monitors School procedures. Our Ethics Officers have delivered lectures, seminars, and workshops on ethics and research governance for staff, PGR students and research groups. We hold fortnightly ethics 'drop-in' clinics, offer individual

appointments, and support approximately 130 ethics enquiries per year from our research staff and PGRs. A series of 'ethics toolkits' were developed for students and supervisors including a guide to the application process and templates for documents required. Research integrity training is mandatory for all researchers (Section 2).

2. People

Our researchers work across the translational spectrum of Discovery to Society, from fundamental, through preclinical and clinical, to public health and social research. At the REF2021 census date (F/M): 32% (47/53) of research staff were employed at Professorial level, 26% (56/44) at Associate Professor/Principal Research Fellow level, and 41% (58/42) at Assistant Professor/Research Fellow level. 6% (50/50) of our staff are early career researchers, 11% (67/33) are on fixed-term contracts, 16% (88/12) have part-time contracts, 7% disability declared, 14% (47/53) from BAME groups.

Our allied health professional staff act in positions of leadership at the highest levels of the University (e.g. Deputy Vice-Chancellor Cox (2013-2017) (nurse); Pro-Vice-Chancellor for Research and Knowledge Exchange Tendler (2013-2015) (pharmacist) and *Corner** (2015-) (nurse); Pro-Vice-Chancellor for the Faculty of Science *Shakesheff* (pharmacist)). We consistently have staff representation on UoN Council (*Corner**, *C Roberts*), Senate (*Walker*, *Anderson*, *Allen†*, *Blake†*, *Boyd†*, *Hui†*, *C Roberts*, *Toh†*), UoN Executive Board (*Shakesheff*, *Corner**), UoN Research Committee (*Corner**, *White** and one of our PGRs), and other University committees with representation at all career levels, helping develop leaders of the future.

2.1 Staffing Strategy and Staff Development

Building a Sustainable Staffing Strategy: Our strategy is to recruit and retain the best talent. We have appointed* a total of 33 Category A research staff at professorial (11) and non-professorial level to create and maintain critical mass in key research areas in line with strategy. 23 staff have retired or left. Interviews for staff include panel members from across the UoA (trained in Interview Skills for Chair and Panel Members). We have an anonymized applications system in which biographical data is removed prior to shortlisting in order to reduce the risk of unconscious bias.

We have invested strategically in all areas across our **Discovery to Society** activities: We appointed four Assistant Professors in areas of Inflammation Biology (*Piccinini**, 2015 Anne McLaren Fellow), GPCR Pharmacology (*Kilpatrick**, 2020 Anne McLaren Fellow), RNA Biophysics (*Hori**, 2020 Nottingham Research Fellow) and Bioelectronics (*Rawson*†*, 2016 Nottingham Research Fellow), and one Associate Professor in Supramolecular Chemistry (*Perez-Garcia*†*, 2017 Anne McLaren Fellow). Building our biomaterials and analysis activities we appointed four Assistant Professors in Regenerative Medicine (*White**, 2016 Anne McLaren Fellow), Biomaterials (*Hook*†*, 2018 Nottingham Research Fellow), Bioinspired Therapeutics (*Chauhan**, 2019 Nottingham Research Fellow), and Mass Spectrometry (*Griffiths**, 2020 Anne McLaren Fellow). To deliver our research strategy in *Additive BioFabrication* we appointed one Professor as a 50% appointment with Engineering in Biomedical Engineering and Biomaterials (*Mata**, 2019). Eight Professorial staff have been appointed in the areas of Hearing Science (*Baguley**), Maternal Health (*Higginbottom**, 2015-2018 and *Verhoeven**, 2020), Children and Young People (*Coad**); Skin Integrity (*Tanner**, 2014); Mental Health (*Slade**, 2015), Rehabilitation (*Sackley**, 2019) and Palliative and End-of-Life Care (*Harwood**, 2018). Associate Professors were appointed in Older Person's Care (*Goldberg*†*, 2014), Midwifery (*Pallotti**, 2017), and Psychological Therapy (*Garland**, 2019). Assistant Professors have been appointed in areas of Respiratory Clinical Pharmacy (*Sonnex**, 2017), Respiratory Rehabilitation (*Harvey-Dunstan**, 2018), Epidemiology (*Otete**, 2017-2018), and to reflect priorities in internationalization we appointed two Assistant Professors in International Pharmacy (*Arakawa**, 2018; *Toh**, 2019) and one Associate Professor in International Pharmacy and Traditional Medicines (*Zhu**, 2016). *Borelli** and *Latif** were both appointed in 2015. We have strengthened our digital technology expertise by appointing an Associate Professor in Medical Education Informatics (*Konstantinidis**, 2015). In 2018, *Needham** was appointed as Professor of Translational Therapeutics to lead our Laboratory-to-Clinic Translational Research in Cancer activity. Dame

Jessica Corner*, Professor of Cancer and Supportive Care, joined the University in 2016 as Pro-Vice Chancellor for Research and Knowledge Exchange.

Our commitment to the development of early career researchers is demonstrated by our appointment of fellows to the Anne McLaren (aimed at outstanding female scholars in science, technology, engineering and medicine) and Nottingham Research (targeted at exceptional postdoctoral researchers in all academic disciplines) fellowships; launching their independent research careers (*Chauhan**, *Dixon*†*, *Griffiths**, *Hook*†*, *Hori**, *Kilpatrick**, *Piccinini**, *Rawson*†*, *White**, *Wilson** (from October 2020)) [REF5a-2.1c]. The Fellows are given a permanent contract, subject to meeting predefined objectives, at the end of their 3-year Fellowship. Our two 4-year joint AI-Biomaterials Discovery Fellowships (recruitment delayed until 2021 due to COVID) will be hosted by SoP for the first six months, followed by up to 36 months in the MIT Anderson and Langer labs and Koch Institute, before returning. These fellowships will provide additional funding to cover research expenses, travel, consumables, childcare support and other expenses associated with the fellowship of up to £90k for the four years. Fellows will have access to mentoring, career development and networking with the wider fellowship community. We have established mechanisms for knowledge sharing within and across UoA themes and for supporting and mentoring potential Fellows in developing their proposals and establishing the networks and infrastructure to support success.

With the appointments outlined above, and with internal promotions, we have a sustainable balance of academic staff at all career levels.

Staff Development: Personal development and research career progression are reviewed on at least an annual basis through UoN's Appraisal Development Conversation (ADC) process. We provide financial support for undertaking 'long' courses, clinical courses, sabbaticals and short courses, attendance at national and international conferences (with support for childcare and other caring cover), and shadowing opportunities. We support staff to undertake further research degrees (e.g. *Zelzer†* Bioinformatics Scientist Apprenticeship (2020-2022)) and have supported staff with doctoral study (e.g. *Borrelli†*, *Carter†*, *Sonnex**).

- **Performance and progression:** We have recognised the contributions of research staff through 63 Exceptional Performance Bonuses and rewards through the Nottingham Reward Scheme. In line with principles of responsible metrics, *h*-index and other publication metrics are no longer an assessment criterion for promotion. Staff applying for promotion are offered mentoring from a senior staff member, and all staff are offered an annual preparatory workshop for preparing a promotion case. Through ADC we have approved 38 promotions[†] in core research areas of our UoA which has enhanced sustainability of our research:
 - 11 promotions to Professor (*Bath-Hexall†*, *Allen†*, *Laughton†*, *Coulson†*, *Rose†*, *Pollock†*, *Aylott†*, *Stolnik†*, *Chan†*, *Stocks†*, *Naylor†*) [5F, 6M]
 - 19 promotions to Associate Professor (*Blake†*, *Evans†*, *Goldberg*†*, *Edgley†*, *Pollock†*, *Parry†*, *Buchanan†*, *Fisher†*, *Thomas†*, *Boyd†*, *Mantovani†*, *Gershkovich†*, *Rawson*†*, *Perez-Garcia*†*, *Dixon†*, *Dreveny†*, *Jopling†*, *Kim†*, *Zelzer†*) [12F, 7M]
 - 8 promotions to Senior Research Fellows and Assistant Professor (*Hook*†*, *Carter†*, *Caswell†*, *J Roberts†*, *Fletcher-Smith†*, *Hui†*, *Parmenter†*, *Borrelli†*) [5F, 3M].
- **Coaching, Mentoring and Leadership:** 20 of our research staff have undertaken the UoN's Leadership and Management Academy taught programmes [REF5a-3.1]. Four of our staff have secured competitive places on the Nottingham Research Leaders Programme (*Aylott†*, *Blake†*, *Radford*, *Thomas†*). Three staff secured places on our award-winning ESRC Impact Leaders Programme, established in 2015 to foster collaborations with external stakeholder partners to promote the exchange of people, ideas, skills and knowledge. In 2018, UoN established a pioneering Vice-Chancellor's Mentoring Programme for staff, who have protected characteristics and leadership aspirations. Staff members from our UoA have been selected for this scheme each year (2018: one Professor; 2019: two Associate Professors).
- **Staff Wellbeing:** We secured two institutional awards in the Nottinghamshire County 'Wellbeing@Work' Workplace Award and contributed to shaping UoN Wellbeing Strategy

2020 through our representation on two UoN Task & Finish Groups for Wellbeing and Staff Engagement.

- ***Research Capability:*** We enhance capability of our research staff through annual research staff away days, monthly methodology seminar series and specialist methods groups, including realist methods, implementation science, health economics, and protocol writing. We host an innovative Grant Writing Workshop seminar series for the SoM (*Radford*) and co-lead the Joanna Briggs Centre for Evidence-Based Healthcare (*Evans[†]*), which provides expertise and training on Review Methodology. Since 2014, we have invested in additional statistical support for research staff and PGRs (medical statistician delivers ~80 consultations-per-year). We hosted a Marie Skłodowska-Curie actions Research and Innovation Staff Exchange project *FutForm* to translate advanced analytical approaches embedded into industrial practice for the development of future pharmaceutical processes through a collaborative programme of researcher secondments with SMEs in Twente, Porto and Sicily (*Allen[†]*).

Developing Clinical Academic Careers: We are leaders in developing clinical academic careers from pre-masters through to professor. Our aim is to give clinical academics the applied skills to become leaders in healthcare research. We offer an integrated Clinical Academic Programme for non-medical healthcare professions including the MA in Research Methods (*Edgely*), NIHR/HEE Internship, Pre- and Post-Doctoral Bridging Programmes, and the Centre for Doctoral Training (CDT) for Rehabilitation and Healthcare Research. *Coad[†]* is one of our two Directors of Clinical Academic Careers to strategically and operationally support East-Midlands implementation of these priority areas:

- ***Clinical Academic Pre-Doctoral Research Training:*** Our UoA hosts a masters in applied research methods (MARM), which includes undertaking a clinically-relevant research project and the development of a protocol for a clinical academic PhD. Our MARM programme was one of only 10 such courses in England and received annual institutional National Institute for Health Research (NIHR) funding for 10 fully-funded places until 2018.
- ***NIHR/HEE Clinical Academic Pre- and Post-Doctoral Bridging Programmes:*** This scheme (led by *Radford*) identifies up to seven non-medical NHS clinicians from the East Midlands each year from the NIHR/HEE list of ICA eligible non-medical professions. Each fellow is matched with an academic and clinical mentor and provided with bespoke training over 48 weeks, resulting in a completed PhD proposal and NIHR clinical academic fellowship application. Of the 29 clinical academics who have completed the pre-doctoral fellowship, 11 have been awarded a PhD fellowship including three NIHR CDRF fellowships and three NIHR CLAHRC PhD fellowships.
- ***Regional Influence:*** We work in partnership with the University of Lincoln who run the HEEM Internship Programme and provide management support and mentoring of health professionals across the HEEM/NIHR ICA pathway (*Radford, Logan, Coad[†]*). We host and deliver the HEEM pre-doctoral and post-doctoral fellowships (*Logan, Radford*) We input into the Health Education England East Midlands Internship Clinical Scholarship, the NUH mentorship programme, and have secured The Healthcare Improvement Studies (THIS) Institute funding to support clinical PhD studentships (*Spiby, Fisher[†]*). We lead in supporting regional excellence in clinical academic careers through the clinical academic practitioner network and steering group championed by NIHR ARC East Midlands (*Coad[†], Radford, Logan, Spiby*).
- ***Medical Lectureship:*** We host a unique medical lectureship post in SoM that allows a medical practitioner (usually a senior doctor) to undertake a PhD while in a clinical post. The success of this post is demonstrated by a strong track record of progression to senior clinical academic careers through this route (e.g. *Harwood[†], Gladman*). The last three post holders now hold one Associate Professor and two Professor positions.

2.2 Research Students and their Training

Our PGR community of 219 comprises 54% Home, 12% EU, 33% International, 7% part-time, 57% female, 37% BAME, and 9% declared disability. Our PGRs are from 31 countries, and we have attracted 30 recipients of the Vice-Chancellor's International Scholarship. Over the REF period we have graduated 537 (418.41 supervisory FTE) PhDs with an average 4-year submission rate of 84%. Funding is received from the UKRI, industry and major charities. We have supported a growing number of studentships over the REF period to the point where for 2020/21 we will be spending over £800k p.a. on studentships.

Effective and Sustainable Postgraduate Training: Postgraduate strategy is overseen by the SoP PGC (*Jopling*[†]), the SoHS PGR Committee (*Moffatt*), SoM Division of Rehabilitation Ageing and Wellbeing PG Lead (*Buchanan*[†]) and CDT-RHR Management Board (*Logan*), who are responsible for PG recruitment, new course recommendations, investment of School funds in PhD training (ca. £250k) and governance of the PhD programmes. We have PGR Student Representatives on all programmes (SoP 10, SoHS 6, SoM 3).

- **Collaborative PGR Research and Training:** We have led two highly successful industry-backed EPSRC CDTs in Targeted Therapeutics (£1.3M 2011-2017 *C Alexander*) and Advanced Therapeutics & Nanomedicines (£4.6M 2014-2022 *C Alexander*). The UoN-UCL collaboration that is the academic backbone of these CDTs is one of Europe's leading industrial collaborative training programmes in advanced drug delivery. Increasing numbers of industrial partners have contributed funding for students over time. 50% of the graduates from these CDTs have taken high-profile roles in R&D across partnering companies (AZ, GSK, Pfizer), 28% in academia, and others in diverse, life sciences, R&D intensive organizations (e.g. Unilever, UCB, Syngenta, Vertex). We also partnered in the EPSRC & MRC CDT in Regenerative Medicine (£1M co-Is *Buttery*, *Shakesheff*). We again lead the CDT in Transformative Pharmaceutical Technologies with UCL and the Synthesis & Solid State Pharmaceutical Centre in Ireland (£6.1M + €3.0M 2019-2027 *Stolnik*[†]), with support from 11 industrial partners, that will train and prepare 75 strategic-thinking scientists for high achieving careers in the pharmaceutical and healthcare sectors.

We remain the UK lead and on the Management Board of the NanoFar Erasmus Mundus Joint European Doctorate in Nanomedicine and Pharmaceutical Innovation (*Bosquillon*). We established a PhD/MRes programme in Pharmacology and Drug Discovery with Monash in which students spend time at both institutions and are awarded a joint UoN/Monash PhD. We have established two Thematic PhD training programmes through the UoN's EPSRC DTA; Bioinstructive Materials for Healthcare Applications (2018-2022 *Rose*[†]); Astropharmacy and Astromedicine (2019-2025 *Williams*), which is supported by collaboration with the Adelaide Centre for Sustainable Planetary and Space Resources providing studentships on the Nottingham/Adelaide Partnership and Dual PhD programme. We have hosted 39 industrial studentships (including CASE awards) over the REF period with support from 20 companies including AstraZeneca, GlaxoSmithKline, Alliance Boots, Pfizer, NPL, Unilever, Syngenta, Croda and Widex A/S.

Our Centre for Doctoral Training in Rehabilitation and Healthcare Research (CDT-RHR), launched in 2014 (Director: *Logan*), supports doctoral training for clinicians and applied health services researchers, offering an innovative, integrated, programme of research training and development, with core-training on mixed methods research in complex interventions. The CDT-RHR collaborates strategically with the ARC and the EMAHSN (East Midlands Academic Health Sciences Network) who provide complementary expertise in applied clinical research. To date 14 people have graduated from the CDT-RHR, with 5 being successful at winning post-doctoral fellowships.

Our Centre for Doctoral Training in Musculoskeletal Health and Pain in Ageing and Wellbeing: (Co-Director: *Gladman*) collaborates closely with CDT-RHR and provides translational research training for 91 PhD students of whom 27 are AHPs. The centre collaborates with the Pain Centre Versus Arthritis, the Centre for Sport, Exercise and Osteoarthritis Research Versus Arthritis and the MRC Versus Arthritis Centre for Musculoskeletal Ageing Research.

- **Skills & Training:** The Midlands Graduate School ESRC Doctoral Training Partnership provides matched studentship funding, local and cross-institutional training to our PGRs in social science research methods and skills, as well as broader capabilities such as communication and leadership. The DTP offers 17 different training pathways, with studentships awarded annually across the pathways and partner institutions (Aston, Birmingham, Leicester, Loughborough, Nottingham and Warwick).
- **Recruitment:** We recruit PGRs from a wide range of backgrounds through targeted advertising, and work with local clinicians to support their career. For our EPSRC CDTs, we hold a Virtual Open Day online run by current students from our EDI Working Group. We also run an online application session in early January for any prospective applicants with queries about the application/selection process. Applications to study are anonymized to ensure that shortlisting is based purely on merit. Interview panels are constructed to ensure a gender balance and representation of diverse backgrounds.
- **Health & Wellbeing:** We lead a 'Wellbeing Showcase' for PGRs with external speakers and interactive sessions. In 2016, we founded the UK's PGR-led 'Raise Awareness of Mental Health in Higher Education' campaign to remove stigma around mental health in higher education. Our launch conference was attended by 165 staff, students, and mental health service providers from the Universities of Nottingham, Birmingham and Warwick. In 2020, we ran a number of Mental Health and COVID support sessions on behalf of the Researcher Academy for all postgraduate students across the Schools.
- **PGR Supervision Excellence:** Our staff consistently receive student-nominations and win awards for their research supervision (e.g. THE Awards Zelzer[†] 2016, UoN Staff Oscars Blake[†] 2017, Moffatt 2018).
- **Research Outputs and Impact:** PGR students make a significant contribution to our research portfolio, co-authoring over 750 publications in the REF period, >100 returned to REF2021. Over 150 publications co-authored by our PGR students on the EPSRC CDTs in Targeted Therapeutics and Advanced Therapeutics and Nanomedicines have been published in the period, including outputs in *Nature Communications*, *PNAS*, and *Science Advances*. The success of our support for early career researchers is demonstrated by the prestigious achievement awards received by our research students, such as the Tri-Campus Postgraduate Endowed Award (Quirk, Oliveira, Banerjee, O'Connor, Bardi, Bin Sabri, Sykorova), and the Anglo-Thai Education Award (Tosangwarn). The PhD thesis of Sweeney 'A convergent parallel mixed methods investigation into the role of mindfulness in moderate to severe, persistent depression', 2016 (results published in *Lancet Psychiatry*), has been downloaded from the repository over 4200 times. Our PGRs generated the first publication of the three-dimensional structure of BabA, an important adhesin used by *Helicobacter pylori* to attach to the human gastric epithelium, in *Science Advances* leading to an EPSRC Postdoctoral Fellowship (Francini). Through our CDTs we have established a collaboration with the Institute for Food Research in Norwich, Vanderbilt University, Max Planck Institute for Infection Biology, and University of Muenster. Robson, a PGR on the Astropharmacy programme, participated in the design and management of the *WormSail* experimental astropharmacy CubeSat satellite.

Many of our PGRs and early career researchers have progressed to academic careers (e.g. seven of our NRF/AMFs came from research positions within the UoA), and secured significant research grant funding from national bodies (e.g. *Henshaw* NIHR RfPB; *Wiggins*, *Rawson*[†] EPSRC).

2.3 Equality and Diversity

Equality, Diversity and Inclusion (EDI) is an integrated priority across the Unit. The UoN's Associate Pro-Vice-Chancellor for Equality, Diversity and Inclusion was a member of our UoA (*Walker* 2015-2018). In line with the UoN's EDI Strategic Delivery Plan, our UoA has two Directors of EDI, one in each Faculty (FMHS: *Walker*; FoS: *Shakesheff*) liaising with Faculty HR Business Partners. Within our Unit we have EDI leads in each School reporting to FMHS EDI Group (*Walker* co-chair) and Faculty of Science EDI Group (*Shakesheff* co-chair) who report to

the PVC for EDI. These staff lead on the implementation of the equality, diversity and inclusion plans for respective Schools, monitoring all aspects of EDI and recording progress, celebrating success and recommending EDI priorities for development. In SoHS, EDI is monitored by chair of the Career Development and Inclusion Board and represents SoHS on both Faculty and University EDI committees. In SoM, the Career Development Engagement Committee & Executive, the Wellbeing and Engagement Group, and the Strategic Staffing Group are now brought together into The People's Committee. In SoP, EDI is monitored by the Equality and Diversity Committee.

Our commitment to the EDI agenda is evidenced by our Silver Athena Swan awards with leads in each school. EDI is a standing item on our Research Strategy Board agendas, and we hold regular EDI-themed seminars. We are actively involved in driving the University's and national agenda on EDI. Locally, we have representation on the UoN Diversity and Inclusion Research Steering Committee led by the PVC for EDI (*Blake*[†]). *Shakesheff* and another member of our UoA sit on the Race Equality Charter Self-Assessment Team, and contribute to the UoN application for the Bronze Race Equality Charter mark. We lead EDI-related research funded by the STEMM-CHANGE Programme (EPSRC Co-I *Walker*) (e.g. *Toh*^{*} leads the development and testing of COVID-19 discrimination reporting system and is working with our Institute for Policy and Engagement to extend nationally [REF5a-2.1e]) and the Sphere Programme (*Blake*[†]). On a national level, *Henshaw* sits on the NIHR Equality, Diversity and Inclusion Advisory Board.

EDI and the REF submission. The University supported employees to voluntarily declare relevant personal circumstances and their impact on volume of REF outputs [REF5a-3.7]. All staff involved in internal REF preparations completed a bespoke masterclass: REF, Equality, Diversity and Inclusion Training (covering EDI legislation and principles governing REF conduct, protected characteristics, unconscious bias, management strategies for positive outcomes).

All researchers were asked to nominate as many outputs as they thought eligible for inclusion for REF2021 to our annual internal review process, and all were encouraged to put forward impact case studies (ICSs). Our strategy is to submit the very best outputs and ICSs regardless of other criteria. The eight ICSs submitted are from the work of 11 female and 8 male researchers: 8 Professors, 5 Associate Professors, 2 Assistant Professors, 3 Principal Research Fellows and 1 Nottingham Research Fellow.

2.4 Concordat Implementation

We have strategic roles explicitly designed to support researchers to develop both capacity and their careers, ensuring local implementation of the Nottingham Concordat Plan [REF5a-3.2]. These include our Directors of Research (*Williams*, *Drummond* 2019, *Goldberg*[†], *Fisher*[†]), Directors of Knowledge Exchange (*Goldberg*[†] 2017-9, *Evans*[†] 2019-22), Research Concordat Officer (*Evans*[†]). Research Integrity is central to staff induction processes and PhD programmes [REF5a-2.4]. From our undergraduate, postgraduate and staff training activities of the Schools, research integrity is discussed as part of research ethics, in terms of good scientific practice e.g., observing high standards, compliance, honesty as a researcher, and, bad practice, such as, misconduct, and self-interest. As a member of the UK Research Integrity Office (UKRIO), the University has access to training provision of UKRIO on research integrity and organised research integrity workshops for academic staff and research students from 2017. Responsible Research and Innovation training is provided by the Institute of Science and Society at the University – the one of the foremost interdisciplinary centres for research excellence in the field of science and technology studies.

3. Income, infrastructure and facilities

Research Income: Since 2014 our total grant spend has been over £58.2M with funding from a broad portfolio of sources (UKRI contributing 38%, UK Government 31%, charities 15%, EU 8% and industry 5%). Our research awards for the same period total over £75.6M (based on percentage shares of UoA3 staff only) from our participation in over £175M of interdisciplinary research awards across the Institution.

National Research Programmes: We are key members of national funded research programmes, including *Radford* (ChI) NIHR Return to Work After Stroke (RETAKE) study with Leeds; *Logan* (ChI) NIHR Falls in Care Homes (FInCH) study involving 11 NHS trusts; *Harwood* (ChI) NIHR PrAISED study involving 5 NHS trusts; *Aylott*[†] (co-I) EPSRC Future Targeted Healthcare Manufacturing programme led by UCL; *C Alexander* (co-I) EPSRC Future Vaccine Manufacturing programme led by Imperial College; *Mata*^{*}, *Rose*[†], *Shakesheff*, *White*^{*} (co-Is) UKRI MRC UK Regenerative Medicine Platform Hub-2 led by Imperial College; *Rose*[†] EPSRC Engineering Growth Factor Microenvironments led by Glasgow; *Stocks*[†], *C Roberts* (co-Is) EPSRC Prosperity Partnership with Strathclyde; *C Roberts* (co-I) EPSRC Enabling Next Generation Additive Manufacturing programme grant with Nottingham UoA9, 12 and Birmingham, Warwick; *M Alexander*, *C Roberts* (co-Is) EPSRC Formulation for 3D Printing platform with Nottingham UoA5, 6, 8, 12 and Birmingham, Reading.

Nature and Quality of Infrastructure and Facilities: We have access to excellent facilities across both Faculties of Medicine and Health Sciences and Science. The Biodiscovery Institute (BDI) (deputy director *Rose*[†]), opened in 2019 with the £23M investment into the Centre of Biomolecular Sciences, sees the physical linking of the Boots Science Building (housing Advanced Materials and Healthcare Technologies (AMHT), Molecular Therapeutics and Formulation (MTF), Regenerative Medicine and Cellular Therapies (RMCT)) and the Centre of Biomolecular Sciences (Biomolecular Science and Medical Chemistry (BSMC), RMCT). BDI enabled the co-location of RMCT with the Division of Cancer and Stem Cells, the Nottingham Breast Cancer Research Centre, the Cancer Pathogenesis Research Group, the Division of Respiratory Medicine and the Stem Cell Biology Units of SoM. These buildings house state-of-the-art facilities in molecular biology, cell culture, mass spectrometry, medicinal chemistry (including our 80,000-compound library), structural biology, molecular modelling, microscopy, parasitology and formulation. Using the BDI as a focus, the Director (UoA1) worked with *Williams* and others to provide 16 of the 35 qPCR machines sent to the UK Biocentre in Milton Keynes for COVID-19 testing.

Other important facilities that we access include the nmRC (co-located with some of AMHT) that underpins more than £100M of UoN's research portfolio and has secured £7.6M of EPSRC capital funding in the REF period (including the only 3DOrbiSIMS in academia (*M Alexander*, *C Alexander*, *Scurr*, *Shakesheff*, EPSRC EP/P029868/1), a high resolution, cryogenic analytical and transfer scanning electron microscope (with *C Alexander*, *Parmenter*[†], *Rawson*[†], *Scurr*, EPSRC EP/S021434/1) [REF5a-4.2]), the School of Life Sciences Imaging centre (including £735k for the multidisciplinary super-resolution microscopy facility; co-Is *C Roberts*, *Buttery*, *Aylott*, *C Alexander*, *Rose*[†], *Williams*, *Shakesheff*, BBSRC BB/L013827/1), equipment at the Research Complex Harwell (including multiwavelength analytical centrifuge, co-I *Dreveny*[†]; BBSRC BB/R013411/1), flow cytometry centre (including an imaging flow cytometer (co-I *M Alexander*, Wellcome Multi-User Grant) and the UoN's High Performance Computing Facilities (upgraded 2018). In 2016, *C Roberts* secured £800k from the Wolfson Foundation to establish a GMP facility within the £24M Advanced Manufacturing Building, opened in 2018, for work on additive manufacture of pharmaceuticals. We (*Laughton*[†], *Williams*) are actively involved in developing the Digital Research Environment Strategy of the University, which includes infrastructure and resource (£3.1M, 2016) for Compute and Analytics, Research Data Management, and Communication and Collaboration [REF5a-4.1d]. Over the REF period our researchers have been supported with over £90k through UNICAS, the long-standing University initiative that brings together cross-discipline groups to fund exciting, novel research projects involving analytical science.

Our hearing science research benefits from bespoke auditory laboratories and acoustic and hearing equipment that have been purpose-built and continually developed. *Naylor*'s team moved to new laboratories in Jan 2014 (total bill approx. £875k) and has since benefited from MRC capital-investment in portable systems for talker selection and paired eye-trackers for tracking people while they converse (£144k, MRC). The BRC has gained a fNIRS system (£263k, MRC).

Significant capital investment has been made within SoHS to create flexible clinical skills research and training space (£925k), in improvements in the working office environment (£930k) and provision of communal catering (£370k). We provide dual-screen desktop or laptop to all PGR students.

Effective Equipment Use and Renewal: We have contributed to the UoN's initiative on equipment sharing through our EPSRC NanoPrime project, led through the nmRC, that aims to catalyse the development of nanomaterials research across the University through equipment and expertise sharing (*M Alexander* with UoA8 and 12; EP/R025282/1).

The Schools have also invested in equipment since 2014: In SoP funds for new equipment are managed by the SRC (annual budget of £100k) taking in account of our and UoN's strategic priorities and ensuring open facilitated access and sustainability, inclusive of renewal strategies. Small equipment and upgrades funded this way include: DynaPro plate reader, IVIS maintenance, AEKTA START FPLC, Mastersizer, Agilent UV and Fluorescence spectrometers. We recently invested in a Facilities Management System, which through linking with individuals' diaries and accounting tools enables researchers to better plan their research, aids in cost recovery and accounting, and has proven invaluable in the safe and effective recovery of research from the COVID-19 lockdown.

Enabling Impact: Our Interface and Surface Analysis Centre (ISAC) partnership between SoP and the National Physical Laboratory continues to develop the awareness of our surface and interfacial science capabilities driving commercial engagement. In the REF period, ISAC has delivered over £1.5M of projects across a broad range of industrial sectors (e.g. working with Innospec Ltd to inform the development of 10 new fuel additives (combined sales of \$200M) reducing gasoline environmental and health impact and shaping the strategic development of their fuel additive business (\$600M revenue); undertaking forensic analysis for Guilford Performance Textiles to discover the origin of contaminants; understanding skin permeation of key active ingredients in a skincare product range helping secure international patent applications, pre-launch product development and post-launch product validation analysis; working with a multinational pharmaceutical company to study compounds for cataract prevention and treatment).

Cross-HEI Shared Facilities: In 2016, the UoN and the University of Birmingham established the £10M *Centre of Membrane Proteins and Receptors* to develop novel methods for visualising single membrane proteins and to use these to identify new approaches for prevention and treatment of cardiovascular disease and cancer angiogenesis, of which *Emsley* and *Kellam* are group leaders. The imaging infrastructure created through this centre has been instrumental in achieving many significant outputs (eg. *Science*, *J. Med. Chem.*, *Front. Pharmacol.*). The *End-to-End Therapeutics* IRC, co-led by *Kellam*, is positioned to build upon this, the BRC and other activities across the university to deliver four different-stage translation pipelines. We are also partners, contributors and users of the £6M (co-I *Emsley* £3.7M Wellcome Trust) Midlands Regional Cryo-EM facility.

Industry-funded research: Our staff have forged strong links to many healthcare and related industries resulting in 44 collaborative projects worth over £2.6M over the REF period. We work with 38 companies across the healthcare sector, including Boots, Evonik, Mars Petcare UK, Promega, SureScreen Diagnostics, Syngenta, Unilever, Vectura and Widex A/S. Our four CDTs (EPSRC Targeted Therapeutics, EPSRC Advanced Therapeutics & Nanomedicines, EPSRC Transformative Pharmaceutical Technology; MRC Regenerative Medicine) all have strong industrial links. The Targeted Therapeutics and Advanced Therapeutics were part-funded by industry, as is the CDT in Transformative Technologies CDTs by 11 companies (AstraZeneca, Quotient Sciences, Upperton, Nemauro, Mikota, RAFT, Croda, Pfizer, Arcinova, Catalent, 3M).

Estates Strategy and EDI: To March 2020, researchers in UoA3 had 24-hour access to offices and facilities. COVID-secure working is now enabled through our Facilities Management System and controls to both labs, offices and prayer spaces. Graduate Centres exclusively for PG students are provided at each campus (bookable seminar rooms, computers, kitchen facilities,

lounge and relaxation areas, career libraries), and the £22M newly-rebuilt Engineering and Science Library includes bookable individual and group study areas and PG-only study space. Since 2017, we have been actively involved in significant estates developments in our areas, including refurbishment of office spaces, provision of unisex toilets to meet the needs of gender transitioning staff and students, and provision of parenting rooms (with sinks and refrigeration). Imaging and signage have been under review over the last year to ensure that signs are more inclusive to those with literacy issues or colour blindness, and marketing demonstrates diversity. Additional disabled and late (post school drop-off) parking areas have been provided.

Significance of Major Benefits-in-Kind: A number of our researchers access national and international facilities including Diamond, the ISIS Neutron and Muon source, and the European Synchrotron Radiation Facility funded via the STFC (£134k, £152k and £75k, respectively), and use the UK supercomputer ARCHER via HECBioSim (170MAUs, notional value £95k). Other in-kind support includes loans or access to equipment from industrial partners, staff time donated to supervision of projects by industrial collaborators, and time donated by external consultants and industrial colleagues in providing strategic advice.

Data management: In order to support appropriate data management and governance arrangements for clinical studies the UoN has established a centralised Data Management Service that provides a tiered service to suit the needs of individual researchers and studies, ranging from the development of bespoke databases and data management systems, through to providing infrastructure, training and support for investigators wishing to perform their own data management. This service delivers standardised processes, best practice guidance and quality assurance for all members of staff and postgraduate students. Our Research Computing and Data Manager supports research areas requiring uplifted specialized support of high demanding/big-data management.

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

Collaboration and internationalization are key aspects of our work and culture in Discovery to Society. We collaborate with academic and industrial groups locally, nationally and internationally, as evidenced through our grant portfolio, patents, invitation to conferences and publications. We have catalogued over 70 substantive academic international collaborations, publishing >1000 papers with them in the period, including MIT, Harvard, Monash, Ulm, LaTrobe, University of Toronto, China Pharmaceutical University, Lawrence Livermore National Laboratory, University of Queensland, University of Zurich, and University of Otago, New Zealand. Our organizational restructuring furthered our Transatlantic Target-Based Drug-Discovery (TransTar) programme with LNBio, CNPEM, and Unicamp (*Kellam*; Brazil; CAPES, Newton Fund, British Council) and germinated the tripartite research agreement on drug discovery for tropical and neglected diseases with the Institute of Hygiene and Tropical Medicine (NOVA University of Lisbon; WHO) and Farmanguinhos (Brazilian Ministry of Health). From our 2015 MoU with the University Kebangsaan, we have created joint PhD studentships and research programmes investigating the unmet needs of stroke survivors in mainland Malaysia. We have signed MoU/MoAs with the Department of Pharmacy at National University of Singapore, the College of Pharmacy at Seoul National University, and China Pharmaceutical University in Nanjing, China.

Our research networks include those of *Slade** who is the lead of the Recovery Research Network - the world's largest network (960 members in 36 countries) of researchers involved in mental health recovery – and the European Network for Mental Health Service Evaluation (ENMESH 2017-2021); *Fisher*† the NIHR ARC Stroke Group; *Walker* the World Neuro-Rehabilitation Federation (WNRF) Stroke Special Interest Group & Stroke Rehabilitation and Recovery Roundtable (SRRR) international working group; *Drummond* 'Life after Stroke' committee (Domain 7) for the Action Plan for Stroke 2018 – 2030; *Naylor* was the President of the International Collegium of Rehabilitative Audiology. *Wiggins* is also an invited expert to the WHO's global Make Listening Safe initiative, aimed at protecting the hearing of young people. Hearing Sciences are an institutional member of the WHO's World Hearing Forum. We are

members of the Health and the Midlands Mass Spectrometry networks of Midlands Innovation, and the £6.8M Mental Health and Productivity Pilot funded by Midlands Engine.

NHS clinical positions and roles

Our staff hold joint clinical positions with local NHS trusts: Nottinghamshire Healthcare NHS Foundation Trust (*Baguley**; *Kontou*; *Slade**); Nottingham CityCare Partnership (*Logan*); Nottingham University Hospitals NHS Trust (NUH) (*Coad†*; *Gladman*; *Harwood**). *Kontou* was also Clinical Psychologist with Derbyshire Community Health Sciences NHS Trust and later Derbyshire Healthcare NHS Trust. Six clinicians hold honorary positions within this UoA, for example *Carter* as Child and Adolescent Mental Health Service nurse. *Carter* is also Affiliate Cognitive Behavioural therapist at Trent Psychological Therapies Service. Our PGR student body includes consultant-level clinical staff. *Spiby* is a member of the Executive Board Nottingham and Nottinghamshire Local Maternity and Neonatal System. *Pallotti** is Board Member and Vice Chair of the Iolanthe Midwifery Trust, and Director of the Sheffield Maternity Cooperative. *McDermott* maintains her position as Music Therapist for the Central and North West London NHS Foundation Trust. *Drummond* is a Non-Executive Director at University Hospitals of Derby and Burton NHS Foundation Trust.

Blake† sits on the Nottingham University Hospitals NHS Trust Staff Health & Wellbeing Board. We work closely with the Institute for Mental Health (co-Directors *Gladman*, *Slade**). We collaborate with MindTech (the NIHR Healthcare Technology Co-operative focused on the development of new technology for mental healthcare), Health Education East Midlands, and EMAHSN. With a focus on research implementation, members of our UoA hold current or previous roles within the NIHR ARC/CLAHRC (*Walker*, *Fisher†*, *Gladman*).

Public engagement

We organize and participate in a wide range of public engagement and impact activities as part of the Festival of Science and Curiosity, Festival of Social Science, Science in the Park, Pint of Science, British Science Association lectures, Royal Society Summer Exhibition, Cheltenham Science Festival, MayFest/Wonder, SPARK, Summer Scientist, Café Connect, Nottingham in Parliament, UoN YouTube Science Channels, Women in Maths, Research in Action: Impact and Innovation Showcase. We have held Special Exhibitions of 3D printed Medicines at the Science Museum, London, and the Science Museum, Manchester. Outreach and research engagements of ISAC include hosting of the Nottingham Summer Schools 'Getting Under Your Skin' and 'Pharmaceutical Guess Who', six eight-week undergraduate summer research projects, and funding of research conferences. Our After School Science Club, coordinated with the Widening Participation (WP) team and involving approximately 50 pharmacy undergraduate and PGR volunteers, engages with children in 10 local schools each year in a 5-week programme to encourage them to think about science as a career.

In 2017, SoHS appointed a Director of Public Engagement and a Public Engagement Steering Group that includes PGR members. 17 grants were later awarded through a collaborative funding scheme developed to promote grass-roots innovation of co-produced practice between academics and members of the public across research and teaching. Public Engagement webpages have been developed as well as a new (GDPR-compliant) database of service users and carers who collaborate with the School. SoP's Outreach Coordinator (*Collins*) works closely with the Director in SoHS on public engagement, and with the STEM and WP teams with the Faculties through membership of the Faculty of Science Faculty Public Engagement committee, the Practitioners of Outreach group, and is Assessor for the STEM module of the Nottingham Advantage Award.

Patient and Public Involvement

PPI underpins the research activity in Discovery to Society of all components. The SoM has a dedicated working group to raise awareness, embed training and support a wider East Midlands network (chaired by *Fisher†*). Hearing Science researchers play an active and prominent role in PPI at the BRC and School level. We co-created the East Midlands Lay Assessor training programme and the East Midlands Sharebank (a novel model, based on reciprocation, for

organisations/staff/patients/public to share PPI research knowledge and skills). Service users engage in all aspects of research including consultation, collaboration and partnership, engagement in data collection and collaborative analysis, and co-leading studies. In addition to PPI groups attached to specific research teams and funded studies, we have established PPI groups hosted within SoHS and SoM. We deliver three Managed Innovation Networks for PPI supported by the IMH: Mental Health and Hearing Loss; Mental Health and Modern Slavery; the Youth Mental Health Advisory Group (*Wright, Carter*). We host several PPI groups which actively engages service users' and carers' involvement in research: The Nottingham Stroke Research Partnership Group (*Fisher[†], Walker*); the Nottingham Maternity Research Network (*Spiby*), the Dementia, Frail Older Person and Palliative care PPI Group (*Goldberg[†], Pollock*), Nottingham International Collaboration on Educational Research Group, and the Trauma Research Partnership. The Nottingham Stroke Research Partnership Group leads an annual Stroke Lay Conference and attracts over 120 stroke survivors, carers and family members affected by stroke. We have delivered training to service users in research methods to support their involvement in externally funded participatory research undertaken across the UoA. *Hui* hosts research workshops at the Nottingham Recovery College, which is a session co-lead by service users for service users, to develop research knowledge, skills, training, ideas and networks. *Slade** is the Academic Lead for PPI within the Mental Health and Technology Theme of the NIHR Nottingham BRC. We have engaged in significant capacity-building amongst community organisations and supporting their work in advocating for changes to healthcare practice, particularly for migrant communities (*Evans[†]*).

Media Activities

We have engaged in significant media activities for knowledge transfer and public engagements (e.g. dissemination through local and national BBC television and radio, The Conversation, The Washington Post, The Smithsonian Magazine, Velopex UK, YouTube and other social media platforms).

Influence on the local economy and community

We contribute to the local economy through spin-outs and engagement with local businesses. Molecular Profiles (*Davies, C Roberts, Williams*), sold to Catalent in 2018, focusses on early-stage development of small molecule drug candidates from the bench to clinic and employs 150FTE. *C Alexander, Dixon, Rose* and others consult for Locate-Bio (CSO *Shakesheff*). Locate-Bio, formally Locate Therapeutics, had a significant investment from Mercia Technologies in 2018 bringing the total investment to £8M and employs researchers in the area of regenerative medicine. *Shakesheff* is Non-Executive Director of Biocity Group, a life-sciences business incubator with five sites in Nottingham, Macclesfield and Glasgow, and is Chair of the Civic and Regional Committee, which has oversight of UoN's civic and regional engagement and develops strategy to direct our civic and public value contribution [REF5a-2.2d].

Indicators of wider influence

All members of the Unit are proactive in undertaking activities that support the research base. In this section highlights are chosen to span all themes and Schools and to reflect all career stages.

Awards and Fellowships: In the REF period staff have received many prestigious Fellowships and awards, including: *Davies* – CBE for services to pharmacy and pharmaceutical science (2018); *Coad[†]* – Fellow of the Royal College of Nursing (2013); *Logan* and *Radford* – Fellow of the Royal College of Occupational Therapists (2015, 2019); *Shakesheff^P* – EPSRC RISE Award (2014); *Anderson* – Fellow of the International Pharmaceutical Federation (2015); *C Alexander* – Royal Society Wolfson Research Merit Award (2016); *Crawford* – Fellow of the Royal Society for Public Health (2018); *Baguley* – British Tinnitus Association Shapiro prize (2017, 2018, 2019); *Sackley* – Fellow of the Chartered Society of Physiotherapy (2018); *Knaggs* – Fellow of the Faculty of Pain Medicine, Royal College of Anaesthetists (2016); *C Alexander* – Fellow of the Institute of Materials, Minerals and Mining (2018); *Baguley* – Royal Society of Medicine Section of Otolaryngology Gamble Research prize (2018); *Walker* – Professional Excellence Award, Stroke Association (2015) and RCOT Excellence in Occupational Therapy Award (2018); *Wharrad* -

Wharton-QS Reimagining Education Gold Award (2018); *Hook* – Vickerman Prize, US Surface Analysis Forum (2018); *Sackley* – Elected member of the Academia Europaea (2019); *Piccinini* – Elected member and Trustee British Society for Matrix Biology (2019); *C Roberts* – Academy of Pharmaceutical Sciences Award (2019); *Shakesheff* – UK Society for Biomaterials President's Award (2019); *Williams* – Fellow of the Royal Society of Biology (2019); *Kellam, Knaggs and Boyd* – Fellow of the Royal Pharmaceutical Society (2014, 2014, 2020). In 2016, *C Roberts* was listed by *Medicine Maker* on the Power List of Top 100 most influential people in the world of drug development and manufacture.

Our staffing strategies and staff development processes have resulted in significant success in winning prestigious research fellowships, including:

British Tinnitus Association Senior Research Fellowship, *Sereda* (2015)

EPSRC E-TERM Landscape Fellowship, *Delcassian* (2015)

EPSRC Foresight Fellowship, *Aylott* (2016)

EPSRC Healthcare Technologies Impact Fellowship, *C Alexander* (2016)

Horizon 2020 Marie Curie Sklodowska Global Fellowship, *Delcassian* (2018)

NIHR Career Development Fellow, *Henshaw* (2018)

NIHR Senior Investigator, *Logan* (2019)

Stroke Association Postdoctoral Fellowship, *Kontou* (2015)

Stroke Association HRH The Princess Margaret Senior Lectureship Award, *Fisher*[†] (2016)

Visiting positions: We receive regular visiting international scholars in our fields, and host a Visiting Chair in Vascular Medicine. *Coulson* is a Visiting Professor of Health Psychology, Staffordshire University, and *Carter* has a visiting scholarship with London Southbank University. *Walker* is Honorary Professor at the University of Queensland, and University of Gothenburg. *Hendrick* was Adjunct Professor University of Saskatchewan in 2016, *Drummond* was an Australia Visiting Scholar in 2017, and *Henshaw* was Honorary Senior Research Fellow at Macquarie University Sydney, 2017-2018. *Naylor* was a Distinguished Scholar in Residence at National Center for Rehabilitative Auditory Research, Oregon (2014-2016) and on their Scientific Advisory Board (2017). *Stocks* was a visiting lecturer at the Shanghai University of Traditional Chinese Medicine (2017). *Buchanan* received Thousand Talents Award for a visiting scholarship to Tianjin Normal University, China 2017-2020

Journal Editing: Our staff serve on the Editorial Boards of >90 journals including: *Age Ageing*, *Ear & Hearing*, *Cancers*, *Biochem. J.*, *BMC Pregnancy and Childbirth*, *J. Psychiatr. Ment. Health Nurs.*, *J. Chem. Biol.*, *Surf. Interface Anal.*, *Br. J. Health Psychol.*, *Int. J. Stroke*, *Br. J. Neurosci. Nurs.*, *Cell Death & Disease*, *The Practising Midwife*, *Clin. Rehabil.*, *Int. J. Pharmaceutics*, *Biomaterials Science*, *Br. J. Pain*, *BMC Health Services Research*, *Microscopy and Analysis*, *Midwifery*, *J. Music Ther.*, *Open Health*, *Sci. Rep.*, *Life*, *J. Med. Chem.*, *Stroke*.

Grant committees: Staff have taken roles on grant committees and charity grant awarding bodies and strategic committees, including: EPSRC: Peer Review College; Resource Allocation Committee; ARHER Science Advisory Committee; ARCHER embedded Computational Science and Engineering panel. BBSRC: Research Committees C & D Core Members; ALERT panels. NIHR: Clinical and Senior Lectureship committees; Chair Senior Investigator Selection Panel; Programme Grant for Applied Research committee; Long COVID Funding Panel; HTA Clinical Evaluation and Trials Panel; Research for Patient Benefit Panel Chair; Doctoral Research Fellowship Panel; Health Technology Infrastructure Centre Awards committee. H2020 expert review. Action Plan for Stroke Chair. UK Stroke Association Chair Rehab Awards Committee. German Systematic Review Panel. UKRI Future Leaders Fellowship Panel. Wellcome Trust Basic Science Fellowship Committee.

Services to advisory panels, grant committees, and professional bodies: *C Alexander* was Chair of EPSRC Physical Sciences Strategic Advisory Team (2016-2019) and is a member of the EPSRC Science, Engineering and Technology Board. *Anderson* is Chair of the Royal Pharmaceutical Society, English Pharmacy Board. *Evans*[†] is a founding member, and *Coad*[†] Chairs the Clinical Academic Roles Implementation Network and is member of the research

advisory group of the Council of Deans of Health. *Shakesheff* is Board Chair of the National Centre for Replacement, Refinement and Reduction.

National and international advisory roles: Our staff act as specialist advisors to national groups and societies such as the Stroke Association (*Drummond, Walker*), British Geriatrics Society (*Gladman, Harwood, Logan*), UK Occupational Therapy Research Foundation Advisory Group (*Fisher*[†]), Royal College of Nursing (*Hui*), British Society for Audiology - Dementia Guideline Development Group (*Wright*), British Society of Audiology Practice guidance and Tinnitus & Hyperacusis Special Interest Group (*Sereda*), Men's Health Forum Advisory Group for Digital Peer to Peer Support (*Coulson*[†]), Multidisciplinary European Tinnitus Guidelines (*Sereda*), UKSBM (*Blake*[†]), WHO (*Slade*^{*}), International Confederation of Midwives Research Advisory group (*Spiby*), Australian Stroke Centre of Excellence NHMRC, The Florey Institute and University of Oslo Rehabilitation Research Centre, Norway (*Walker*) and EU Stroke (*Drummond, Walker*). *Knaggs* is a member of the Advisory Council on the Misuse of Drugs and Chair, Technical Committee. *Drummond* is a member of the Executive Advisory Group of the Australian Universities Syndicate. *Walker* is UK lead for rehabilitation research priorities in the European Stroke Organisation Action Plan for Europe 2018-2030, *Drummond* sets research priorities as Chair of the Life after Stroke Stream, in the European Stroke Organisation Action Plan for Europe 2018-2030. We have representation on the Royal College of Physicians Intercollegiate Working Party for Stroke (*Drummond, Thomas*). *C Roberts* is an Advisory Group member of the Wellcome-sponsored Boots Online Archive Project.

Other national positions and roles: *Spiby* is chairing the 5-year review for the Scottish Government Chief Scientist's Office Nursing and Allied Health Professions Research Unit (2017-2022). *Crawford* is Director of the Centre for Social Futures at the IMH. *Evans*[†] is Co-Director of the Centre for Evidence Based Healthcare; a 'Centre of Excellence' within the global Joanna Briggs Institute network.

Many of our members are Trustees and hold significant positions (Treasurer, Advisor, Committee Chair, etc.) with charities, including the British Geriatric Society, Dog's Trust, Stroke Association, Dunhill Medical Trust, Ossie Newell Foundation Trust.

Contributions to national and international guidelines: Our staff have contributed evidence and testimony to parliamentary committees and review bodies, including to the Secretary of State for Education on policy development for mental health in schools 2015; House of Commons Digital, Culture, Media and Sports Committee Inquiry 2018; All-Party Parliamentary Group on Arts, Health and Wellbeing Inquiry Report Creative Health 2018; the 2019 Independent Review of the Mental Health Act 1983. Staff advise bodies in specialist areas of health and wellbeing, including to Equality and Human Rights Commission, Cabinet Office; Health Education England; and NHS England and NHS Improvement; Royal College of Physicians; Welsh Centre for Public Policy; the expert working group for the revision of Ethics Guidelines for Internet-Mediated Research.