Institution: University of Wolverhampton

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

1. Unit context and structure, research and impact strategy

1.1 How Research is Structured across the Unit

Research in Unit of Assessment (UoA) 3 is facilitated through the Research Institute in Healthcare Science (RIHS), a multidisciplinary, cross-Faculty research institute (RI) with members drawn from the Schools of Science (*22 staff*), Pharmacy (*12 staff*) and Medicine & Clinical Practice (*9 staff*) in the Faculty of Science and Engineering (FSE); and the Caring for Lifelong Health Research Centre (*11 staff*) situated in the Faculty of Education, Health and Wellbeing (FEHW). The number of Category A staff submitted to REF2021 has increased by almost 70%, from 32 returned in REF2014 to 54 (47.3 FTE) in the current submission, reflective of significant levels of investment in staff and infrastructure by the University.

The research objectives of RIHS have continued to evolve in response to national and global healthcare priorities and are reflected in a restructuring in 2018 to build larger, multidisciplinary research groupings that are organised around four themes in areas of key strengths, detailed below and in Figure 1. Research objectives in these themes are delivered by subgroups focusing on specific aspects of each integrated portfolio. Each subgroup is led by a senior staff member with support from academic colleagues, postdoctoral researchers, postgraduate research students (PGRs) and technicians. There is considerable complementarity both within and between research themes and this matrix model provides a stimulating and vibrant environment for staff and students who are able to contribute to multiple research subgroups in different themes. RIHS has also initiated a range of cross-disciplinary research programmes with University colleagues in Psychology, Computer Science, Engineering, Social Policy, Sports and Art, recognising that this type of collaborative effort is critical to successfully tackle complex health issues (Figure 1 and Sections 1.3, 1.4).

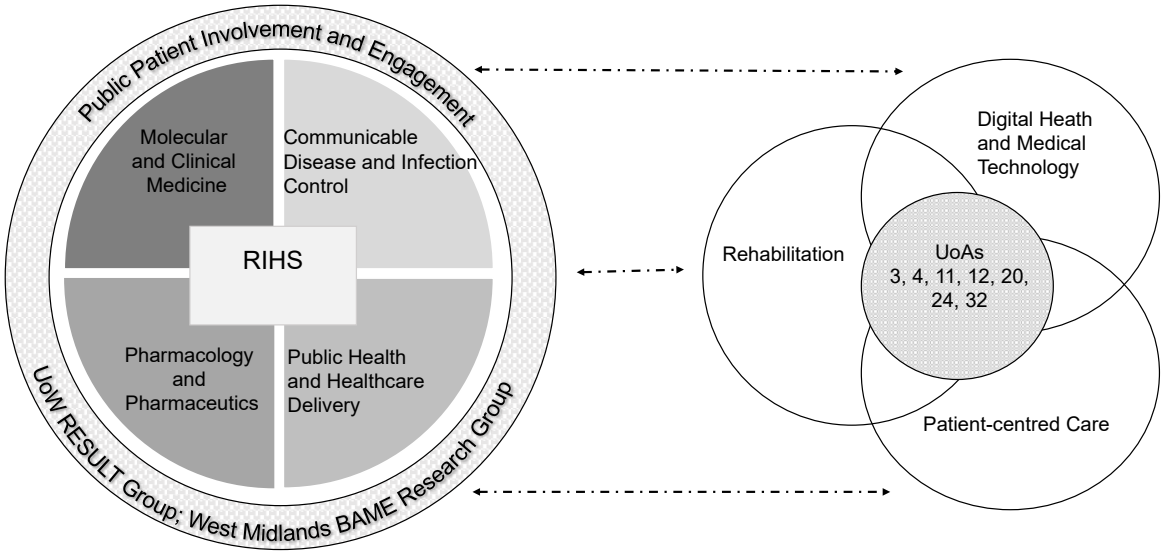

Figure 1. RIHS core research themes and developing inter-disciplinary collaborative programmes

Research in RIHS is informed by service users and patient beneficiaries through the University's Public and Patient Involvement and Engagement (PPIE) group, RESULT (Research Enabling Service-Users and the University to Learn Together), established in 2015 to promote the interests of patient and public representatives in health research.

RIHS' core research themes comprise:

Molecular and Clinical Medicine *(Armesilla, Attridge, Barrow, Basu, Brookes, Clark, Conner, Cotton, Churchill, Day, Dunmore, Gama, Goggolidou, Kirkham, Moore, Morris, Nicholl, Ojo, Omar, Patel, Pillay, Steed, Tang, Wang, Warr)*
Research in this theme is focused on understanding cellular and molecular mechanisms underpinning biological and clinical aetiology of chronic disease (*cardiovascular disease; chronic obstructive pulmonary disease (COPD); ciliary disease; diabetes; inflammatory bowel disease*) and cancer (*bone, breast, brain, colorectal, lung, myeloma, pancreatic, renal, metastases*) and the development of novel targeted therapeutic strategies. Complementary workstreams include investigations of inflammatory and immune response; interactions with tissue microenvironment and microbiome; and establishment and validation of new, representative pre-clinical disease models.

Communicable Disease and Infection Control *(Bartlett, Basu, Brookes, Dunmore, Gibson, Heaselgrave, Low, Manning, Morrissey, Omar, Rahman, Roberts)*
This theme encompasses research in a diversity of novel anti-microbial strategies to combat infectious disease including optimisation of antimicrobial effectiveness in chronic wound care; antimicrobial resistance in respiratory infections and impact of pneumococcal vaccines; diagnosis and treatment of *Acanthamoeba keratitis* and contact lens disinfection; and molecular aetiology of food-borne pathogens including *Campylobacter* and *Clostridium*, and use of probiotics to reduce infections in the food chain. Researchers are also developing novel ex-vivo systems to model microbial infections.

Pharmacology and Pharmaceutics *(Armesilla, Ball, Elsaid, Heaselgrave, Howl, Jones, Kaialy, Low, Moore, Morrissey, Nicholl, Ojo, Rahman, Tang, Wang, Warr, Wright)*
In this theme, researchers are engaged in drug design, formulation and delivery innovations to advance research findings generated in the Molecular Medicine and Communicable Disease themes as well as pursuing independent research strands. There is an emphasis on drug repurposing and repositioning in addition to the design, synthesis and evaluation of novel drug analogues. Strategies to improve bioavailability of therapeutic compounds include utilisation of delivery mechanisms (nanotechnology, liposome encapsulation and bioportides) and enhancement of physiochemical and mechanical properties of pharmaceuticals. A relatively new workstream focusses on novel biotherapeutics including cell secretomes and microbiomes.

Public Health and Healthcare Delivery *(Antoun Rey, Ball, Barratt, Bond, Chen, Drozd, Jester, Jutlla, Lim, Matheson, Morrissey, Murandu, Pillay, Purewal, Rahman, Steed, Thomas)*
The emphasis of this research theme is to investigate the causes of disease and health inequality using population-bases methodologies and to improve healthcare service delivery and practice. Workstreams include epidemiology, medication adherence and patient-centred communication to enhance management of chronic, non-communicable disease (*cardiovascular disease, cancer, COPD, dementia, diabetes, psychiatric disorders, stroke*) in community and primary care settings; chronic wound care and models of service delivery; and nutrition support and medication behaviour in parenteral fluid systems.

RIHS also accommodates research in Forensic Science, with a focus on molecular anthropology, microbiological taphonomy and forensic genetics (*Rogers, Schmerer, Whitehead*).

1.2 Research Objectives Past and Future and Performance

The overarching vision of the research undertaken in RIHS is to understand human disease at cellular, individual and population levels and to use this knowledge to improve survivorship and quality of life and care. In 2014, research in UoA3 was predominated by a relatively small number of laboratory-based disciplines and hence, the RIHS research strategy outlined in REF2014 focussed on consolidation of areas of strength in biomedicine and pharmacology and developing opportunities for translation of academic research activities to address healthcare problems.

Considerable progress has been made towards achieving this aim through the enhancement of our strategic partnership with the Royal Wolverhampton NHS Trust (RWT). The University and RWT have a proven track record of collaboration since 2010 in a small number of important clinical disciplines (cardiovascular disease, gastroenterology, diabetes, oncology) and the University has provided investment of GBP 1 million from its Research Investment Fund in the current REF cycle to strengthen translational medical and clinical research. The appointment, in 2019, of 7 RWT Consultants to fractional Professorial academic positions in Clinical Medicine at the University (Basu, Brookes, Churchill, Cotton, Gama, Pillay, Steed) and a programme of jointly-funded PhD studentships between the University and RWT has strengthened existing networks and provided new opportunities for RIHS to engage in health research, particularly in clinical biochemistry, haematology, neonatology, obstetrics and pharmacy practice. Additional new collaborations have been established with clinical consultants in RWT and other NHS Trusts (including Birmingham Women's and Children's NHS Foundation Trust; Dudley NHS Foundation Trust; Sandwell and West Birmingham NHS Trust; University Hospitals of Derby and Burton NHS Trust) in the fields of infectious disease, COPD, kidney disease and cancer diagnostics.

RIHS has also expanded its research portfolio to introduce new complementary disciplines in patient-facing healthcare practice, public health and clinical epidemiology with the appointment of 11 new staff in these areas, including three Professorships (Learning and Teaching-Health, Bond; Nursing, Jester; Pharmacy Practice, Ball). These new research programmes have advanced the evidence base of health care practice, informed the development and provision of innovative cost-effective services and ultimately impacted positively on patients' experiences and outcomes as detailed in Section 1.3.

In 2018, University signed a MoU with West Midlands Ambulance Service which has now become the first University Ambulance Trust in the UK. Members of RIHS are working with the new Trust on research initiatives in clinical practice, major incident response and management and clinical data management. Joint research is developing beyond healthcare projects to encompass cyber-security, workforce planning and transport modelling.

Our strategy for 2021-2026 will build on these successes to deliver research that is innovative and impactful, and that aligns with the global, national and regional health objectives of Horizon Europe, UK Research and Development Roadmap and the West Midlands Combined Authority. In addition to strengthening research portfolios in our four core themes, we will also engage in forward-looking, multi- and inter-disciplinary research programmes to achieve patient benefit, including:

1) In partnership with colleagues in UoA11 (Computer Science) (detailed in Section 1.4) and UoA12 (Engineering), we will grow the Digital Health and Technology programme with integrated workstreams to include:
    - using artificial intelligence (AI) and machine learning (ML) to interrogate large biological data sets derived from '-omics" platform analyses of tissue in multiple diseases. Molecular data will be integrated with clinical image analysis (MRI scans, X-rays, pathology micrographs) to develop novel prognostic and predictive patient stratifications of disease progression and response to therapy
    - developing portable/wearable, non-invasive sensors for continuous measurement and monitoring of biomarkers eg glucose levels, SpO2, heart rate, blood pressure

- employing additive manufacturing to develop novel antimicrobial materials to reduce infection transmission in healthcare settings.

2) We will expand our collaboration with colleagues in the Sport and Physical Activity Research Centre (SPARC), the Centre for Psychological Research, and computing to develop a new research area of Rehabilitation with workstreams including:
   - efficacy of exercise in chronic disease with RIHS members providing expertise in longitudinal tracking of molecular markers; use of patient reported outcome and experience measures; and development of e-learning materials for healthcare practitioners
   - influence of psychological and socio-economic factors on patient acceptability of interventions and development of education tools to effect behavioural change
   - creation of software tools to support recovery and self-management of long-term conditions.

3) Together with colleagues in from the Institute for Community Research and Development and key stakeholders and beneficiaries in the University's RESULT group and regional NHS Trusts, we will progress our work in Patient-centred Care. In addition to our core research subgroups, we will collaborate in a programme to investigate patients' digital abilities and exclusion from digital models of healthcare delivery. We will also expand provision for PPIE, including increasing the numbers and diversity of the membership of RESULT.

Underpinning these objectives is our commitment to continue to invest in the RIHS research community for all members through:

- increasing external income by 30% over the next REF cycle, with an emphasis on responding to Horizon Europe, NIHR and UKRI funding calls that are compatible with our research objectives, detailed in Section 3.1
- enhancing opportunities for staff development, increasing the number of promotions and timely succession planning to retain expertise and ensure sustainability of research disciplines
- increasing our PGR recruitment from 25 to 40 enrolments per year, whilst continuing to provide a stimulating and supportive environment.

1.3 Impact from the research and the link to Impact Case Studies

RIHS is predicated on the concept of enabling staff with complementary skill sets across academic and clinical disciplines to work together to address complex healthcare challenges and to facilitate impact. The implementation of the thematic research groupings and the formalisation of our research collaboration with RWT have enhanced the opportunities for successful translation of applied healthcare research into practice, evidenced in our 4 submitted Impact Case Studies (*Enhancing professional practice and public understanding of end-of-life care and organ donation,* ICS *Organ Donation; Enhancing person centred care through improving clinical communication,* ICS *Communication; Improving the wellbeing of populations at risk of digestive and eating disorders, Digestive Health*; *Improving health and wellbeing of patients with cancer through exercise-based rehabilitation,* ICS *Cancer Exercise*) and wider contributions.

Influencing and informing healthcare practice guidance and policies

RIHS researchers engage with professional organisations, including the National Clinical Research Networks (NCRN), National Institute of Clinical Excellence (NICE), Public Health England (PHE), the Royal Colleges and regulatory bodies, to facilitate approval and implementation of recommendations into official policies. Contributions to the development of national and international guidelines include:

- NICE guidelines on "Organ donation for transplantation: improving donor identification and consent rates for deceased organ donation" *(*ICS *Organ Donation)* and "Shared decision making" *(*ICS *Communication)*

- NICE recommendation of the 'Quality of Life Wound Checklist' and its adoption within the Manchester University NHS Foundation Trust Leg Ulcer Pathway *(*ICS *Communication)*
- PHE guidance documents for supporting dysphagia in people with learning disabilities *(*ICS *Digestive Health)*
- Royal College of Nursing national competencies for orthopaedic and trauma nursing *(*ICS *Communication)*
- UK Government guidance for the oral care of people with intellectual disabilities *(*ICS *Communication)*
- Conception and development of the consensus statements for Inflammatory Bowel Disease (IBD) standards for UK NHS trusts *(*ICS *Digestive Health)*
- International expert consensus guidelines on parental provision of micronutrients in adult and paediatric patients (Ball; Morrissey https://doi.org/10.1002/jpen.1525; https://doi.org/10.1002/jpen.1990)

Training and education of healthcare professionals

Research has contributed to the enhancement of delivery of healthcare provision in a number of disciplines and settings including:

- Development of an award-winning specialist training programme by CanRehab UK (www.canrehab.co.uk) to deliver a Level 4 award in Cancer and Exercise Rehabilitation using evidence from a Cochrane review (ICS *Cancer Exercise*)
- Creation and delivery of an exercise-based cancer rehabilitation programme at Dudley NHS Foundation Trust hospitals (ICS *Cancer Exercise*)
- The Stork programme which delivers training to neonatal healthcare professionals and directly to parents/carers (detailed in Section 4.2)

Raising awareness in key beneficiaries and enhancing public understanding

Dissemination of research outcomes to patients and public audiences has been achieved through diverse routes including:

- Development of patient information booklets and online self-help materials for patients with binge eating disorder (ICS *Digestive Health*)
- The "Living in Silence" art exhibition which used innovative, mixed media approaches to destigmatise and improve understanding of chronic IBD in the female South Asian population in Wolverhampton and the surrounding regions in collaboration with the University of Wolverhampton Art School (ICS *Digestive Health*)
- Creation of the unique organ donor memorial sculpture, 'The Gift of Life', situated outside the entrance to the Emergency Department at New Cross Hospital, Wolverhampton (ICS *Organ Donation*)
- Television, radio and press reporting of
    - organ donation awareness and communication strategies targeting BAME communities (ICS *Organ Donation*)
    - development of novel non-hormonal male contraception (detailed in Section 4.3)

In addition to the pathways described above, we anticipate that during the next REF cycle, impact will be realised through commercialisation and licencing of new therapeutic products as the underlying research programmes in disease biology and drug design and delivery mature, including those for which patents are already held by the University (detailed in Sections 4.1 and 4.3).

1.4 Supporting Interdisciplinary Research

RIHS recognises that interdisciplinary collaboration is integral to the achieving the strategic objectives outlined in Section 1.2. New co-operative partnerships developed in the REF census period include:

- The Patient Communication Group, bringing together expertise from RIHS, Psychology, Education and Linguistics, has focussed on clinical consultations, shared-decision making

and person-centred care, culminating in the ICS *"Enhancing person centred care through improving clinical communication".*

- RIHS and SPARC have developed a collaborative programme of work around exercise as medicine, with these synergies leading to the submission of the ICS "*Improving health and wellbeing of patients with cancer through exercise-based rehabilitation"* and the award of University Research Investment Funding for an ambitious programme of interdisciplinary work to investigate cancer and rheumatoid arthritis (commencing 2021).
- Clinical and laboratory members of the gastroenterology research sub-group in RIHS are working with analytical chemists, health psychologists and artists to improve diagnosis and quality of life in patients with IBD and enhance public understanding of this condition. The University is also funding a new project in this sub-group "*An Innovative Diagnostic Test for Bile Acid Malabsorption in Crohn's Disease Patients (ID-BAM)"* to commence in 2021.
- A series of multi- and inter-disciplinary research programmes is planned between RIHS and colleagues in computing as detailed in Section 1.2. One project, using AI and ML to build data models to predict iron deficiency anaemia in pregnancy, has commenced and is supporting a new PhD studentship jointly supervised between computing and RIHS.

1.5 Progress towards an Open Research Environment

The University provides a robust platform for providing green-route open access to all research published through our repository (WIRE) and staff are active in the free sharing of research data, methodologies, reagents and expertise where this does not conflict with the University's IP using appropriate repositories. All RIHS staff have received training in using the research information system (Symplectic Elements) and WIRE and compliance with Open Access is regularly monitored within the Unit and forms a key aspect of the appraisal system for research active staff.

1.6 Supporting a Culture of Research Integrity

RIHS is committed to maintaining the highest levels of research integrity and adheres to the five principles of the *Concordat to Support Research Integrity* and *DORA,* to which the University is a signatory. Details of all University research policies, procedures and guidelines are circulated to RIHS staff, including all updates and revisions by the University's Research Integrity Manager. Research integrity objectives are included in staff appraisals and the annual progress review of PGR students.

All research staff receive the Handbook for Ethical Approval and Practice Procedures as part of induction and all staff research is required to undergo ethical review by either the Life Sciences Ethical Committee in FSE or the Health Ethics Committee in FEHW depending on the subject matter of the proposal. All PGR research projects are subject to scrutiny in the same way as staff projects, thus exposing doctoral students to the principles of ethics at an early stage of their career through constructive feedback. In addition, all research in health and social care undergoes high level scrutiny by the University Sponsorship Sub-Committee before institutional sponsorship is granted, prior to application for HRA ethics and R&D approval.

2. People

Staff and PGR students are integral to the research environment of RIHS. The RI promotes a holistic, inclusive culture in which the research activities undertaken by academic staff and PGR students are augmented by honorary and visiting fellows and underpinned by the strong and well-coordinated support of dedicated teams of staff from Technical Services, the Research Policy Unit, Finance and the Project Support Office (detailed in Section 3.2).

2.1 Staff Strategy

2.1.1 Staffing development and recruitment

RIHS applies the principles of the University's Research Concordat to Support the Career Development of Staff for which the University was awarded the European Commission's HR Excellence in Research Award in 2012, with successful re-accreditation in 2016. This includes a workload model with research time allocations for academic staff ranging from 50% to 11% of total time including:

- Scholarly and Research Activity workload hours of 180-620 hours (800 hours for Professors) based on performance criteria of quality of research outputs, evidence of impact, external research funding, internal and external service
- 180 hours of protected time for Self-Managed Research and Scholarly Activity
- up to 200 hours to support the research of new staff, often ECRs, to support their integration

All RIHS staff are assigned a research mentor and further CPD and training opportunities are identified and actioned through the annual appraisal process. This provides a sustainable research structure within which to nurture junior staff member and facilitate succession planning.

Full-time and part-time staff at all stages of their careers are eligible to apply for research or sabbatical leave. One member of staff was funded with 60 hours study leave to complete 4 manuscripts from their professional doctorate research (Drozd). RIHS has supported several staff with travel and subsistence to visit external institutions in the UK and overseas for periods of up to 4 weeks to undertake collaborative research and training and complete discreet pieces of work (Armesilla; Goggolidou; Jester; Jones; Kirkham; Nicholl; Wang). RIHS has also funded members of the technical support team to attend research development training. QR funding is available to support all staff to attend UK and international conferences if they are presenting authors, invited speakers or attending as a societal committee member or other official representative and in the census period, RIHS has provided funding of >GBP70,000 to support these activities.

RIHS offers opportunities for staff to engage in internal service and contribute to shaping University research policy through representation of the RI on multiple research committees including University Research Committee (Bond, Warr); Doctoral College Advisory Board (Morris); Faculty Research Committees (Ball, Bond, Goggolidou, Jones, Matheson, Morrissey, Warr); Research Awards Sub-Committee (Warr); Researcher Development Concordat Sub-Committee (Goggolidou; Jester); University Ethics Sub-Committee (Warr).

In 2018, 3 members of RIHS (Ball, Walker, Warr; 2F:1M) attended the University's five-day Academic Research and Innovation Leadership Programme, based in the UK and Brussels and organised by the Project Support Office to maximise EU opportunities pre-Brexit and to develop strategic thinking for EU/R&I funds post-Brexit. Subsequently, Ball contributed to a Horizon2020 MSCA-ITN-2019 bid with a consortium based in Denmark, Northern Island, Norway and Sweden.

There have been 36 new Category A appointments in the Unit during the census period covering all disciplines and comprising 67% of submitted staff. Appointing panels give due consideration to the research discipline and interests of applicants and these staff have been recruited to strengthen and enhance the ongoing research strategy and objectives in RIHS (outlined in Section 1.2) in addition to fulfilling curriculum commitments. Shortlisting and interview panels are balanced for gender and ethnicity. Ten positions were at Professorial level (4F:6M; 4 BAME), with 5 new Readerships (2F:3M; 1 BAME) and 21 appointments made at L/SL (10F:11M; 11 BAME).

There have also been 10 internal promotions including 1 to Senior Lecturer (Thomas; 1F), 4 to Reader (Dunmore, Goggolidou, Jones, Walker; 3F:1M) and 5 to Professor (Chen, Kirkham, Tang, Warr, Wang; 1F:4M; 3 BAME). With these new appointments and promotions, the overall demographic profile for staff in the Unit comprises 16 Professors (5F:11M; 6 BAME), 10 Readers (4F:6M; 1 BAME) and 28 L/SL staff (13F:15M; 13 BAME), all of whom are employed on permanent contracts.

2.1.2 Support for staff at the beginning of their careers

Staff are eligible to apply to the University's Staff Scholarship Scheme to cover fees for doctoral degree programmes, with an annual allocation of 70 workload hours to support completion. During the census period, the scheme has delivered one professional doctorate completion (Drozd) and one PhD completion (Eshareturi) with two further members of staff currently enrolled within the Unit.

The University provides an Early Researcher Award Scheme (ERAS) as an opportunity to secure seed core grant funding and deliver a research project that will yield publications and/or development of funding opportunities, coupled with a targeted career development programme. Successful applicants receive a research budget of GBP5,000, 300 workload hours, research skills workshops, action learning sets and dedicated mentoring support. Since 2014, 7 ERAS fellowships have been awarded to members of RIHS in areas including immunosuppression in cancer, delivery of chemotherapeutic, biopharmaceutical and antimicrobial agents, forensic taphonomy, and caring for dementia patients (Attridge, Clifford, Kaialy, Low, McConville, Rahman, Rogers). As a direct result of their ERAS programmes, these staff have collectively produced 14 peer-reviewed articles, secured external research income of GBP198,000 and supervised 18 PhD students as DoS,

In 2020, Clark was awarded GBP10,000 as one of the first Lord Swraj Paul Early Career Research Fund Fellowships for the project *"The Molecular Details of the Human Bodies Fight Against Aging and Age-Associated Disease"* and is leading this interdisciplinary project with collaborators from RIHS (Nicholl) and University of Leicester's Institute of Structural and Chemical Biology (Dr Christos Savva).

All RIHS early-career staff are nurtured within one or more of the 4 research themes and are given opportunities to join PGR supervisory teams as appropriate. They also receive priority allocation of PhD studentships funded by the RI or University. The Doctoral College offers a comprehensive Research Supervisor Development Programme covering all aspects of postgraduate degrees including student well-being, supporting international students (currently comprising 30% of PGR students in RIHS), and conducting or chairing doctoral examinations. The Early Career Researcher (ECR) development programme provides 30 workshops annually and drop-in sessions to support ECRs in the preparation, delivery and dissemination of research. Early-career staff are eligible to apply for seed research funding from RIHS of up to GBP20,000 in their first year of appointment.

2.1.3 Procedures to stimulate and facilitate exchanges between academia and business, industry or public or third sector bodies

Alongside the appointment of 7 Clinical Professors (detailed in Section 1.2), opportunities to increase translational healthcare research have also been strengthened through the award of Honorary and Visiting appointments to NHS consultants including 6 Professorships (Bayliss-Pratt, Nursing and Interprofessional Education; Kirk, Paediatric Research; Livingston, Clinical Biochemistry; Middleton, Public Health; Singh, Metabolic Disease); and 2 Senior Lectureships (Ford, Clinical Science; Min, Chemical Pathology). These are augmented by the appointment of Honorary Research Fellows based in UK HEIs (Maslin, Public Health; Matheson-Monnet, Healthcare Innovation; Salman, Cellular Neuroscience). There are also numerous additional ongoing collaborations between RIHS staff and NHS medical and healthcare practitioners, detailed in Sections 1.2 and 4.1.

The present Chair of the West Midlands (Black Country) REC is a member of staff in FEHW and provides invaluable guidance regarding the NHS ethical framework and preparation of successful applications through IRAS to both PGRs and staff.

RIHS staff also regularly host placements for academics and PGRs from HEI in the UK and overseas for periods of up to 6 months, as part of formal exchange schemes, to conduct collaborative work or to access to equipment and research expertise at the University. These

have included a 12-month Visiting Scholarship for a senior academic from the Affiliated Hospital, North China University of Science and Technology; a 6-month placement for an Erasmus+ project (UNIPHARMAGRADUATES) scholarship awarded by La Sapienza University in Rome; an elective placement for a medical student registered at Exeter University; Clinical Research Fellows; NIHR-funded Clinical Research Interns; and multiple visitors from UK and international HEIs.

RIHS advocates the appointment of external members to PGR supervisory teams where their expertise and experience can augment that of UoW staff. External second supervisors have supported 28 PhD programmes during the census period (including 6 completions) and include NHS consultants and international health practitioners; former UoW staff members; and academics from UK and international HEIs and industry (e.g. Bristol Laboratories Limited; Medical University of Bahrain; University of Colorado; University of Nottingham; University NSW, Sydney).

2.1.4 Recognising and rewarding staff for carrying out research and for achieving impact

RIHS has nominated staff members for the Vice-Chancellor's annual Staff Excellence awards in the categories of *Outstanding Contribution to Research* (Howl, Runner up 2017; Wang - Experimental Cancer Therapeutics Research Group, Winner 2018); *Excellence in Partnership* (Walker, Runner up 2016); and *An Extra Mile* (Rosalind Franklin Technical Services Team, Runner up 2017). In 2017, Howl and Jones were awarded the *Vice Chancellor's Special Award* for their pioneering research using cell penetrating peptides to modulate sperm motility and potentially develop new forms of male contraceptive or enhanced fertility treatments.

Research success and impact are disseminated throughout RIHS via email newsletters and to the wider University community and externally through regular news features on the University website and in Research Matters, the UoW quarterly publication that celebrates research success and opportunities. This magazine has featured numerous articles submitted by RIHS to highlight research activities of its staff and PGRs, including seminal publications, grant income and peer recognition.

2.2 Research Students

Our vibrant PGR student community is a valued component of the research environment in RIHS. Monitoring of progress of PGRs and support for their professional and personal development is embedded in the culture of the RI in order to maximise successful and timely completion of research degrees and to enhance future career pathways for our students.

In the 2019 PRES survey, the University's JACS1 Discipline *Other Health Subjects* scored highly and was placed in the 2nd quarter for Supervision (ranked 12th out of 45); Research Culture (ranked 15th out of 45); Professional Development (ranked 22nd out of 45); and Overall Satisfaction (ranked 19th out of 45). The areas for improvement highlighted in the 2019 PRES survey have been incorporated into the RIHS PRES action plan (Section 2.2.3).

In the census period, there have been 40 PhD completions and 85% of these graduates have secured employment related to health in HEIs, NHS Trusts or industry (Section 2.2.4). Collectively, this cohort of students have 62 peer-reviewed journal articles, including 33 with a PGR as leading author and 31 with multiple PGR authors.

2.2.1 Recruitment of doctoral research students

In addition to the 40 PhD completions to July 2020, a further 84 PGR (78 PhD and 6 MPhil) students are currently registered in RIHS. The growth in recruitment is reflective of the increase in numbers of research-active staff across all disciplines in the Unit and also the introduction of staggered start dates for PGRs throughout the year. In addition, the flexibility of part-time registration facilitates participation in PGR degree programmes for individuals with extenuating personal circumstances, including caring responsibilities, financial considerations and requirement to maintain professional practice in the NHS. Approximately 20% of the current cohort

of PGR students are studying on a part-time basis. Short-listing and appointment panels for PhD studentships are balanced for gender and ethnicity where possible.

2.2.2 Evidence of studentships from major funding bodies

Investment by the University, RIHS, UK research charities and NHS Trusts partner organisations has provided 17 fully-funded PhD bursaries during the census period. This includes 8 PhD studentships for which external funding was matched by RIHS. Although a significant number of PGR students have been funded by overseas government bursaries, there has been a progressive shift towards self-funding for PGR degrees for both home and overseas students and in 2020, 50% of our PGRs are self-financed. Approximately 30% of our current PGR cohort are international students.

2.2.3 Monitoring and support mechanisms linked to evidence of progress and of successful completions

More than 80% of staff with significant responsibility for research are involved in PGR student supervision. The Director of Studies (DoS) is supported by additional members of staff with appropriate subject knowledge and this structure enhances academic, technical and pastoral support for PGR students and also provides opportunities for less experienced members of staff to develop and refine their supervisory skills. External supervisors may be appointed when appropriate to augment the expertise of University of Wolverhampton staff in the team. New members of staff undertake mandatory University research supervisor training and all supervisors are required to undergo periodic refresher sessions. The supervisory team meets at least monthly with the student (bi-monthly for PT students) to provide strategic oversight of the project and to ensure that the student is fully appraised of their progress and provided with feedback on a regular basis. Time for supervisory meetings is an integral component of the workload allocation model for the DoS and secondary supervisors and details of each meeting is recorded by the DoS. Each student participates in the Annual Progress Review process during which 2 independent academic staff assess their progress in data gathering and primary research; personal skills development; and research dissemination and impact over the preceding 12 months. As part of this review, all students complete a Personal Development Plan and a training needs analysis and these are reassessed throughout their degree programme.

The progress of PGR students is overseen by the RIHS or FEHW Research Student Board (RSB) which convenes bi-monthly. Membership of the Board comprises the Director of RIHS (Associate Dean for Research in FEHW), the Postgraduate Research Tutor, the Research Support Tutor, the Research Skills Tutor, 10 additional academic staff covering all areas of research and representatives from the University's Doctoral College and Registry. The RSB considers and approves applications and enrolments; co-ordinates and monitors progression of PGRs including the APR process; monitors supervisory meeting records; scrutinises proposed examination arrangements; assesses skills training provision; monitors progress of the RIHS PRES action plan; and considers additional new initiatives to improve PGR provision tabled by RSB members or PGR representatives.

2.2.4 Support for skills and career development

In 2014, the University founded a Doctoral College that has overall responsibility for PGR student activity, governance and compliance across the University and provides an extensive programme of generic research skills and personal development training, detailed in the Institutional Environment Template, Section 3.2. In response to the 2019 PRES survey, RIHS is delivering discipline-specific training after canvassing the student body for their needs; these include bioinformatics and statistical analysis of large data sets; and ethical frameworks for research in health.

RIHS hosts a monthly external seminar series that is open to all staff and students, with eminent invited speakers from the UK and Europe. In 2019, RIHS implemented a new, mixed format PGR seminar series to provide opportunities for students to develop research and presentation skills and network with their peers and academic staff in a supportive environment. In each session, there are a variety of presentation formats and topics to suit all stages of research degrees

including data presentations; journal club papers; novel technologies; and conference posters/orals, giving PGRs an opportunity to practise accepted abstract presentations for external meetings. Skills sessions are incorporated into the seminar series and Alumni PhD students are invited to present their postdoctoral research being undertaken at their new institutions. PGR students chair these sessions, providing a valuable opportunity to develop this complementary skill set. During COVID restrictions, the PGR seminars were held weekly online to facilitate remote communication and cohesion in the RIHS community. PGR students are also strongly encouraged to present their research at the University of Wolverhampton Annual Research Conference.

RIHS recognises the importance of conference participation for PGR students in order to disseminate data and network with members of the research community in their specialist areas. The RI encourages and supports PGR students to apply for external travel grants but if these are unsuccessful, RIHS provides funding for students to attend at least one conference during their period of registration. A number of PhD students in RIHS have been awarded prizes for the presentation of their research at scientific conferences: SET for Britain Silver Prize, 2016 (Kannappan DoS Wang); Poster Competition Prize British Lung Foundation Alumni Conference 2016 (Kannappan DoS Wang); Best student abstract prize, NCRI Cancer Conference, 2017 (Nkeonye, DoS Wang); runner up best science poster prize, British Neuro-oncology Society Annual Conference, 2018 (Blakeway, DoS Warr). Other student awards include first prize for original research Asian Case Report & Original Article Competition, 2018 (Subasinghe, DoS Morrissey).

RIHS also encourages research placements for short periods of time for PGRs using the national and international collaborative networks of RIHS staff members and appropriate funding from learned societies or from RIHS. Recent placements include;

- 2 months at Sichuan University, Chengdu, China, 2018 (Butcher, DoS Wang)
- 3 weeks at the Warsaw Military Institute of Medicine, Poland, 2018 (Trela, DoS Attridge)
- multiple 2-3 day visits over 4 months to the Centre for Nephrology, Royal Free Hospital, University College London, 2018 (Richards, DoS Goggolidou)
- 2 weeks with Professor Murphy's group at the Sir William Dunn School of Pathology, University of Oxford, 2019 (Richards, DoS Goggolidou)
- 6 weeks in the laboratory of Dr Juan Miguel Redondo at CNIC, Spain, 2019 (Khan, DoS Armesilla)

PGRs have expressed how invaluable they found the experience of working in different laboratory environments and research cultures:

Butcher: "*I would like to thank you for this truly invaluable experience as the challenges I have faced throughout this journey have furthered my confidence both as a scientist and in myself".*

Richards: *"These opportunities have opened new avenues for me to explore during my PhD, given me access to new materials and machinery that I do not have access to at the University of Wolverhampton and has been valuable to my personal development as a researcher"*.

Khan: *"I am so grateful to have been presented with the opportunity to visit a research institute dedicated purely to cardiovascular research. Seeing the expertise practiced in the CNIC has been invaluable for my project and my future career as a researcher*".

In the census period, RIHS has provided funding of >GBP40,000 to PGRs to support these activities.

PGRs are encouraged to disseminate their research to a diverse audience of stakeholders; for example, representatives of charities and other funding bodies; clinical practitioner; MPs and journalists; and non-specialist members of the public during Open Days and outreach events. RIHS plans to provide additional opportunities for PGRs to engage with service users and a lay community through the University's PPIE Group, RESULT.

The quality of PGR provision in RIHS is evidenced by the career trajectory of our PhD graduates. A significant proportion of the students who completed since 2014 have undertaken postdoctoral research (40%) or secured academic positions (20%) at universities including the Babraham Institute, Cambridge; Imperial College London; Kaduna State University, Nigeria; North Western, Chicago, USA; Queen Mary University, London; Ruhuna University, Sri Lanka; and San Jose State University, USA. A further 25% of graduates returned to clinical practice or gained employment in the pharmaceutical industry.

2.3 Equality and Diversity

RIHS values the diversity in its staff and PGR student population and continually scrutinises issues of equality and diversity in all its activities. Staff and students are eligible to engage in all appropriate opportunities, regardless of whether they are employed on FT, PT, permanent or fixed term contracts or studentships. In 2016, RIHS produced a gender equality action plan (GEAP) with the target of increasing gender parity in all research staff and a ratio of 40:60 in the RIHS Readership/Professoriate by 2020. Staff recruitment and development were also monitored for ethnicity. As a result of these activities, the proportion of female staff has increased from 31% in the REF2014 submission to 41% in REF2021 and similarly, the number BAME staff has increased from 22% to 37% in the current REF cycle. The RI supports the University's Leadership programmes for under-represented groups, and since 2014, 4 women and 3 BAME staff have been promoted to Reader and/or Professor, resulting in a RIHS research leadership profile comprising 35% women and 37% BAME staff, compared to the UK average of 28% female and 18% BAME Professors reported by HESA for 2019/20. The current RIHS leadership profile also compares favourably to 2014, when the RIHS Readership/Professoriate comprised only 9% women and 9% BAME staff, although the RI recognises that further improvements are necessary. The University REF Code of Practice was followed in selecting the output portfolio, paying due regard to equality and diversity considerations whilst safeguarding confidentiality. The current PGR cohort comprises 60% female and 69% BAME students.

RIHS also monitors equality and diversity considerations in opportunities for development for researchers at all career stages, including support for ERAS applications; training; promotion; invitations to present keynote lectures and Chair sessions at internal research conferences; representation of RIHS at University Committees and Panels; and distribution of internal research funding. The RIHS RSB scrutinises the composition of PGR supervisory teams to promote gender balance and equality of opportunity to contribute to supervisory activity. In 2014, 47% of supervisory teams were gender balanced and this has risen to 52% in 2020, with a further 11% of female only supervisory teams. RIHS tries to assign female researchers to female mentors where possible whilst ensuring that these individuals are not overloaded to the detriment of their own research career. The programme of invited presenters for the RIHS External Seminar Series is reviewed to ensure gender and ethnicity balance.

RIHS supports flexible and remote working patterns as appropriate to engender participation and inclusion in research activities, retain experience and facilitate succession planning, particularly for individuals with caring responsibilities or underlying health conditions. Internal meetings and other events are scheduled within core working hours and RIHS facilitates attendance at conferences and other external events for staff and PGRs with extenuating circumstances through provision of additional funding to cover travel during peak periods and daily registration costs. In the census period, three members of staff were granted a permanent reduction in hours due to caring responsibilities or as preparation for phased retirement.

Line managers meet with staff before and after maternity, paternity or adoption leave to ensure that they are fully informed of University provision and support and to remind them of opportunities to work flexibly or to reduce working hours. Individuals are also given the option of participating in Keep-in-Touch days, at their discretion. Four members of staff have returned to work on pre-maternity hours and 1 member of staff was granted a permanent reduction in hours. A further member of staff was permitted to move from 0.8FTE to FT hours following a change in personal circumstances. Similarly, staff returning after career breaks, or long-term illness, may request to

change hours temporarily or permanently and phased return to work following long-term illness is managed via a referral to the University's Occupational Health provision.

3. Income, infrastructure and facilities

3.1 Research Funding and Strategies for Generating Research Income

In the current REF cycle, research income totalled GBP1,983,069, a small shortfall compared to that for REF2014 (GBP2,367,039) and this is possibly attributable to changes in staff profile with a significantly higher proportion of early career staff submitted to REF2021. However, we have increased funding by EU government bodies from GBP13,707 to GBP325,570, including 2 prestigious Marie Sklodowska-Curie Actions (MSCA) Fellowships:

- NANODISCAN (EU FP7-PEOPLE EUR299,558)
- DEMAIRPO (Horizon 2020 EUR195,454)

We have sustained our successful track-record of funding from UK-based charities, totalling GBP1,054,721 and accounting for approximately 50% of research income for REF2021. The majority of these awards have been secured in open competition from disease-specific charitable organisations and support laboratory-based projects. We will continue to seek funding from these sources; however, we recognise that the overall funds available from UK charities may be constrained in the short to medium-term as a consequence of the COVID pandemic. During the 2021-26 REF cycle, we will explore opportunities for income generation from key funders who hold research strategies and programmes that align with our research objectives, particularly those that invite cross-disciplinary, collaborative proposals. These include

- Horizon Europe 2021-27 (MSCA; Global Challenges and European Industrial Competitiveness Pillar II-Health; Missions- Cancer)
- Wellcome Trust (Mental Health and Infectious Disease Programmes)
- NIHR (Research for Patient Benefit and Research for Social Care Programmes; Antimicrobial Resistance)
- UKRI (MRC - Better Methods, Better Research; EPSRC – Healthcare Technologies).

Income from PGR research support fees was significantly elevated from GBP45,791 in REF2014 to GBP220,100, reflecting the growth in doctoral registrations, including self-funding students. We anticipate further increases in this funding stream over the next 6 years as we expand our PGR provision.

3.2 Organisational Infrastructure Supporting Research and Impact

Research activities in RIHS are underpinned by essential central infrastructure from the University, particularly with regard to research governance and integrity, finance and impact. Research support services include:

- the RPU which maintains oversight and governance of research policies and procedures (as referenced in Sections 1.5 and 1.6)
- the Doctoral College which administers PGR degree programmes and supports staff and PGR development and training (as referenced in Sections 2.1 and 2.2)
- the PSO which provides support and management for funded projects pre- and post-award.

Information regarding health-related external funding opportunities is provided by one of the PSO's dedicated Funding Information & Research Officers to the Director of RIHS on a weekly basis, for dissemination to relevant staff. The PSO also supports research staff through its Project Bidding Development Team to assist with bid preparation and submission, including budget costings and quality assurance; and the Project Management and Governance Team which provides post-award services. RIHS also benefits from assistance from Faculty Project and Bidding Support Managers and from a dedicated Management Accountant who administers all research budgets in the RI. The Director of RIHS and senior researchers meet monthly with the assigned Impact

Officer to review all aspects of research impact in the RI including research design, partnerships, dissemination and training.

Staff benefit from the support of the University Intellectual Property Manager in preparing patent applications and in the development of commercialisation of their research, with indicative examples in Sections 4.1 and 4.3. RIHS has a dedicated administrator with responsibility for organising internal and external research events and staff travel; and for managing the RIHS RSB (Section 2.2.3).

3.3 Equality and Diversity

The Rosalind Franklin Building (RFB), which houses RIHS research laboratories, is fully accessible for individuals with impaired mobility. The Director of RIHS and the technical services team regularly review infrastructure, equipment, Codes of Practice and Standard Operating Procedures to identify any modifications or revisions that would enable staff or students with physical disabilities to engage in research.

3.4 Research Infrastructure

3.4.1 Provision and operation of specialist research infrastructure and facilities

The University has invested significantly in new infrastructure to support research in RIHS. Since 2014, laboratory-based members of RIHS occupy purpose-built accommodation, on the 4th and 5th floors of the new RFB on the City Campus in Wolverhampton. This GBP 25 million, 7000m^2 building houses both teaching and research laboratories together with research support facilities and flexible exhibition space for outreach work and activities aimed at the public understanding of science. Space for research is greatly expanded over that which was available before 2014, with enlarged facilities for pharmacology and microbiology research including a new fermentation suite. The research laboratories are supported by an experienced technical team with responsibility for the support of the building and general research infrastructure including:

- Safety cabinets, flow hoods and incubators
- Cryogenics
- Autoclave sterilisation
- Human Tissue Authority and Ionising Radiation compliance
- Waste handling and consignment
- Electrical safety compliance
- Specialist gases
- Consumable and specialist research ordering and storage

The University committed a further GBP 2 million to provide major pieces of equipment including facilities for:

- Confocal, fluorescence, laser-capture dissection and scanning electron microscopy
- Mammalian cell culture and manipulation including dedicated facilities for Genetically Modified Organisms
- Genetic analysis, including molecular cytogenetics, sequencing and Q-PCR
- Microbiology including class I and class II containment
- Flow cytometry
- Physiological analysis, including pulmonary function, respiratory VO2 / VCO2 and non-invasive blood pressure
- Pharmacy tableting instrumentation
- Chromatography, including High Performance Liquid Chromatography, Liquid Chromatography Mass Spectrometry and Gas Chromatography
- Thermogravimetric Analysis
- Nuclear Magnetic Resonance (Inductively Coupled Plasma and Infrared Spectroscopy

- Technical staff with specific experimental skills provide maintenance, training and operational support for equipment detailed above.

3.4.2 Cross-HEI shared or collaborative use of research infrastructure

RIHS staff and PGR students make extensive use of collaborative agreements with other HEIs in the UK and overseas to access expensive and/or specialist research facilities, including:

- In-line size-exclusion chromatography small angle X-ray scattering (SEC-SAXS) at the Stanford Synchrotron Radiation Lightsource, Stanford University; and Neutron spin echo spectroscopy at the Institut Laue-Langevin, Grenoble resulting in 2 publications, *Biophysical Journal 115(4):642-654 (2018); PNAS 116(43):21545-21555, 2019* (Nicholl)
- nLC-QTOF mass spectrometry at Aston University (Attridge)
- Cryo-electron microscopy at the Institute of Structural and Chemical Biology, University of Leicester (Clark)
- ChIP-Seq at the Dunn School of Pathology, University of Oxford (Goggolidou)
- Zebrafish models at the Bateson Centre, Sheffield University leading to a significant publication, *Nat Commun. 2019 Feb 13;10(1):732. doi: 10.1038/s41467-019-08590-7* (Armesilla)
- *in vivo* rodent models of disease at multiple institutions including Imperial College London; MRC Harwell; Queen Mary University, London; University of Cardiff; University of Central Lancashire; University of Leeds; University of Manchester; University of Rochester, USA; and University College London, leading to 8 peer-reviewed publications submitted to REF2021 (Armesilla, Goggolidou, Kirkham, Warr, Wang)
- Access to tumour biopsy samples at the Walton Centre, Liverpool and Royal Preston Hospital Joint Tissue Bank through a reciprocal MoU agreement which underpinned income generation of GBP336,000 from UK charities (Morris, Warr).

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

4.1 Arrangements and Support for, and Effectiveness of, Research Collaborations, Networks and Partnerships

RIHS staff collaborate extensively with researchers throughout the UK and globally with notable success as evidenced in selected examples:

- Howl and Jones have a long-standing collaboration with Professor Margarida Fardilha's team at the University of Aveiro, Portugal, to develop and characterise STOPSPERM bioportide technologies for the control of male fertility and to identify cell penetrating bioportides that may selectively induce apoptosis in prostate cancer cells. Joint grant funding has been awarded to support this research from the Portuguese Foundation for Science and Technology (EUR194,317 in 2016: EUR110,000 in 2019) and EPIC-XS Horizon 2020 European Funding for Research and Innovation (EUR25,000 in 2019). Intellectual property arising from this research is protected via two patents co-owned by the Universities of Wolverhampton and Aveiro (Peptides modulating sperm motility by modulating the phosphoprotein phosphatase 1C, International Patent Application No. PCT/GB2018/052046; PPP1CC2 interactome-derived bioportide technologies for the control of sperm motility and male fertility, UK Patent Application No. 1711620.3). Howl is a member of the supervisory team for 2 PhD students registered at University of Aveiro.

- Pillay is the Chief Investigator of a multicentred national study, *OptiPrem: Optimising neonatal service provision for preterm babies born between 27 and 31 weeks of gestation using national data, qualitative research and economic analysis* awarded by the NIHR HS&DR Health Services and Delivery Research (HS&DR) programme (2017-2021). Other participating institutions include the National Neonatal Research Database & Neonatal Data Analysis Unit; Imperial College, London; Nuffield Department of Population Health,

University of Oxford; and College of Health Sciences, University of Leicester. The study aims to assess best place of care (neonatal intensive care unit vs local neonatal unit) for preterm babies born between 27-31 weeks in England using analysis of morbidity and mortality outcomes, cost of care and social ethnography to assess parent and staff perspectives on place of care.

- The PANDA Programme (Primary prevention of maternal Anaemia to avoid preterm Delivery and other Adverse outcomes) is an NIHR-funded collaboration between Churchill and Professor Simon Stanworth, NHS Blood & Transfusion Service and Professor Marian Knight, National Perinatal Epidemiology Unit, University of Oxford investigate all aspects of care required to prevent iron deficiency anaemia in pregnancy and reduce low birth weight and preterm birth. The preliminary work, dose-ranging and behavioural research is centred in RWT under the supervision of Churchill as lead obstetrician prior to the commencement of a large multi-centre RCT.

- In 2019, Basu and Morrissey established the West Midlands Research Collaborative (WMRC). This group is hosted by University of Wolverhampton and NIHR facilitates a robust interface between academia and clinical colleagues from all major hospital trusts in the region (including Heart of England, University Hospital Birmingham, Coventry, City Sandwell, Russells Hall and University Hospitals North Midlands) in order to undertake collaborative research for haematological conditions.

Staff within RIHS hold appointments in a wide variety of HEIs nationally and internationally including 9 Honorary or Visiting Professorships (Charles Stuart University, NSW, Australia (Ball); Anhui Medical University and Guangzhou Medical University, China (Chen); University of Southern Denmark (Jester); University of Messina, Italy (Kirkham); Heibei Union University and Postgraduate Medical School of the PLA, Beijing, China (Wang); Third Military Medical University, China (Wang, Warr). Five further members of staff hold Honorary or Visiting Senior Lectureships or Fellowships at UK and international HEIs (Armesilla, Goggolidou, Howl, Kaialy, Morris). Jester is International Advisor to the Hong Kong College of Orthopaedic Nursing.

In addition to research collaborations detailed in Sections 3.4.2, and the Honorary positions detailed above, staff work in partnership with colleagues at the Centro Nacional de Investigaciones Cardiovasculares, Madrid; Medical University of Vienna,; Medicines Optimisation and Innovation Centre, Antrim, NI; Moorfields Eye Hospital; Sichuan University, China; Universidad de Extremadura, Badajoz, Spain; Universitas Islam School of Pharmacy, Indonesia; University of the Aegean, Greece; University of Birmingham; University of Cologne, Germany; University of Hull; University of Helsinki, Finland; University of Keele; University of Newcastle; University of Nottingham; University of NSW, Sydney, Australia; University of Oslo, Norway; University of Reading; University of Ruhuna, Sri Lanka; University of Southampton; University of Stockholm Sweden; University of Tromso, Norway; University of Umea, Sweden; University of Vig, Spain.

4.2 Relationships with Key Research Users, Beneficiaries or Audiences

Pillay is Programme Director for the STORK Collaborative, anchored in RIHS at the University. The STORK (Supportive Training, Offering Reassurance and Knowledge) programme is an interactive educational empowerment package, designed and developed for parents, carers and families. The training programme focusses on reducing risks for infant mortality with embedding on neonatal units. It has been publicised through the Royal Wolverhampton NHS Trust (https://www.royalwolverhampton.nhs.uk/your-health/stork-reducing-the-risk-of-infant-mortality-in-wolverhampton/), and is now being taken up by NHS Trusts in neighbouring regions (Dudley, Shrewsbury and Telford, Worcestershire). The objective is to help partner teams in neonatal units to deliver a programme that is best suited to their local population through understanding key drivers for community uptake of messages around reducing the risks for infant mortality in the region and implementing change accordingly. Over 1,000 parents have received training in the Royal Wolverhampton NHS Trust neonatal unit alone and has resulted in three parents being able

to resuscitate their own baby (https://youtu.be/2PNu0KGsbh4). There are also online resources with the progressive web app for parents to use on their mobile phones https://storkforparents.goodbarber.app/ which has had 17,000-page views up to May 2020, of which 6,224 were unique sessions.

Heaselgrave is the principal expert for the British Standards Institute (BSI) in the field of contact lens disinfection and UK representative at International Standards Organisation (ISO) meetings. He has worked with other international committee members to develop the new ISO 19045 Acanthamoeba disinfection standard. He has also collaborated with Bausch & Lomb (one of the industrial members of the American National Standards Institute) to optimise the testing protocol for this standard.

Additional engagement of RIHS members with industry includes:

- a Knowledge Transfer Partnership with Malvern Cosmeceuticals Limited (Innovate UK grant *Novel Nanoparticle Targeting of Antimicrobials to Infected Diabetic Foot Ulcers*), to develop novel lipid nanoparticles which can deliver antimicrobials directly into the wound (Heaselgrave)
- a Knowledge Transfer Partnership with Crestwood Environmental Ltd (Innovate UK grant KTP010076), to establish their Environmental DNA (eDNA) provision (Schmerer)
- consultancy to the pharmaceutical company PharmaMax Inc (Kirkham)

4.3 Wider Contributions to Economy and Society

Wang heads a team of cancer biologists and pharmacologists, who have been working since 2012 to improve bioavailability and anti-cancer efficacy of the anti-alcoholism drug, disulfiram, in a range of different tumour types. Patent applications for novel nanoparticle-encapsulated formulations have been granted ('PLGA encapsulated Disulfiram', USA10695299, EP3370706, IN201827020712, CN108513543). In 2018, the University's Knowledge Exchange Team (Pollard) provided support to establish a spin-out company, Disulfican Ltd, with financial investment from University of Wolverhampton and external investor Caparo PLC, to exploit IP assets developed in RIHS. Subsequently, Disulfican Ltd and its Chinese partner Suzhou Bank Valley Nanomaterials Ltd were awarded funding of GBP645,000 from the Jiangsu-UK Industrial Challenge Programme (co-funded by Innovate UK and Jiangsu Science and Technology Department in the People's Republic of China) for the project "*Formulation and testing of PLGA-DS as an anti-cancer therapy for FDA and EMA new drug application*".

The research of Howl and Jones (detailed in Section 4.1) to use bioportides to selectively target post-testicular events and potentially develop a non-hormonal male contraceptive was reported widely in national and international press, radio and television. Howl and Jones participated in a BBC Radio 1 documentary "*The Future of Contraception*" and in Channel 4's "Live Well for Longer" series, episode "*Sex, Drugs and Alcohol*", and the BBC Horizon team to filmed this work being undertaken in the RFB for its episode "*The Contraceptive Pill: How safe is it*?". As a result, the public awareness of issues around effective and safe contraceptive decisions has been raised, particularly in a younger audience.

RIHS regularly hosts work experience placements for local A-level students (> 60) and for Nuffield project students (>30), nurturing the scientific minds of the future and providing inspiration and motivation for them to study life science or healthcare courses in UK HEIs. A research student exchange programme with three universities in India (PSG Institute, Coimbatore; VIT University, Vellore; SASTRA University, Tanjore) has also been established in RIHS, providing an opportunity for 15 (to date) overseas UG students to spend 6 months embedded in a research environment and contributing to ongoing laboratory programmes. RIHS staff have also contributed to STEM outreach and community engagement activities for local schools including a *Science Lecture Series* for 6th form students and "*Female Role Models in STEM*" events for year 5/6 pupils.

4.4 Engaging with Diverse Communities and Publics

The West Midlands BAME Research Group (led by Basu) has a membership of key staff from across Royal Wolverhampton NHS Trust, University of Wolverhampton (Ball, Kirk, Morrissey), University of Birmingham and NIHR CRN West Midlands local NHS organisations representing a number of health specialities in secondary, primary and community care. The Group also has a lay representative from the NIHR CRN West Midlands Equality, Diversity and Inclusion Research Champions Group. The consortium was initially conceived to investigate the disproportionate impact of COVID-19 on BAME communities and has completed "*The Uptake Study: Insights And Beliefs Of The UK Population On Vaccines During The Covid-19 Pandemic*":
https://drive.google.com/file/d/1ZrcidF1cOgjyZzGAjZVK6SOVarFSWdKZ/view?usp=sharing
https://drive.google.com/file/d/1nj93YuldQsB9G2x1dYubDLYh5MqrdrmK/view?usp=sharing
Additional research streams include:

- Healthy ageing in BAME groups
- Local health inequalities, community engagement and participation in health research
- South Asian communities and the impact of Public Health England messages
- Access for BAME groups in postgraduate research study.

RIHS engages with service users through the University's PPIE group in healthcare research, RESULT. Members provide lay support to research activities in RIHS at all stages including development of research proposals and funding applications; help to inform the design of data collection tools; development of patient information leaflets; consent forms or other research materials; and review of ethical issues.

4.5 Contribution to the Sustainability of the Discipline

Churchill is a member of the Steering Committee for the James Lind Alliance Prospective Priority Setting Partnerships: Diabetes in Pregnancy, established between the National Perinatal Epidemiology Unit, University of Oxford, the James Lind Alliance, Diabetes UK, healthcare professionals (HCPs) and people who have lived experience of diabetes and pregnancy. The aim is to produce a top ten list of research questions that women, their support networks, and HCPs agree are the most important for research to address in diabetes and pregnancy. The top ten list will be shared with the public, research funders, national policy makers and clinical studies groups to inform their priorities and strategies for funding research.

In 2019, Brookes undertook a survey in future trainees in Gastroenterology to support the development of the next generation of aspiring principal and chief investigators (Frontline Gastroenterology 2019;10:57-66) and he is now leading a wider engagement process with the Royal College of Physicians to investigate barriers to research engagement amongst newly appointed NHS Consultant Physicians.

4.6 Indicators of Wider Influence

4.6.1 Journal Editorships

Kirkham is Editor in Chief for the Journal of Inflammation. Jester and Bond hold Deputy Editorships for the International Journal of Trauma and Orthopaedic Nursing and BMJ Health & Care Informatics, respectively. Bond is also a member of the Editorial Subcommittee of the Directory of Open Access Journals. RIHS staff serve on the editorial boards for a further 10 peer-reviewed journals.

4.6.2 Participation on Grants Committees

- Brain Tumour Research, Scientific and Medical Advisory Board Member, 2013 – present (Warr)
- NIHR Research for Patients Benefit, Awards Committee Member, 2019 - present (Brookes)

- Guts UK, Awards Committee Member, 2015 - present (Brookes)

4.6.3 Fellowships

Members of RIHS hold Fellowships at the following institutions:

- Royal Society of Biology: Gibson; Jones; Kirkham
- New Zealand College of Pharmacists: Ball
- Royal Statistical Society: Chen
- Institute of Biomedical Sciences: Goggolidou; Heaselgrave
- Australian College of Pharmacy Practice: Morrissey

4.6.4 Membership of Research Council or Similar National and International Committees

Indicative exemplars of representation of RIHS staff on national and international committees include:

- British Society of Gastroenterology Inflammatory Bowel Disease, Committee Member 2018- present (Steed)
- CHIVA (Children's HIV Association UK), Steering Committee Member, 2020 - present (Pillay)
- Department of Health's Task and Finish Working Group on Brain Tumour Research, Committee Member 2015 – 2017 (Warr)
- European Peptide Society, UK Council Representative, 2010 – 2018 (Howl)
- European Peptide Society, Scientific Affairs Committee Member, 2016 – 2020 (Jones)
- European Respiratory Society, Secretary of Group 5.1 Airway Pharmacology & Treatment, 2015 - 2018 (Kirkham)
- Inflammatory Bowel Disease UK, National Board Member 2019 – present (Brookes)
- Innovative Medicines Initiative Horizon 2020 T3, Expert Panel Member 2019-2020 (Matheson)
- Institut Laue-Langevin, Grenoble, College 8 (Biology), Sub Committee Member 2019-present (Nicholl)
- NCRI, Brain Tumour Clinical Studies Group, Novel Agents and Translational Research Sub-group Member, 2010-2016 (Warr)
- NIHR Gastroenterology & Hepatology Joint National Speciality Committee, Co-chair, 2019 - present (Brookes)
- Royal College of Physicians Research, Committee Member, 2020 - present (Brookes)
- NCRI Clinical Research Network (CRN) Myeloma Subgroup, Committee Member 2012 - present (Basu)
- Royal College of Nursing (RCN) Society of Orthopaedic and Trauma Nurses, National Steering Committee Member 2013 – 2017 (Drozd)
- Prostate Cancer Research, Patient Advocacy Committee, Chair 2019 – present (Matheson)
- Royal Society of Chemistry, Protein and Peptide Science Group, 2014 – 2019 (Jones)
- West Midlands NIHR, Deputy Clinical Director, 2019 - present (Brookes)
- West Midlands Research Network GI Research, Specialty Lead and Chair, 2013 – present (Brookes)
- West Midlands NIHR Clinical Research Network, Clinical Research Lead for Haematology and Oncology (DIV1) (Basu)
- UK Obstetric Surveillance System, Steering Committee Member, 2014 - present (Churchill)

4.6.5 Invited Keynotes, Lectures and/or Performances, or Conference Chair Roles

RIHS members have presented > 40 invited or keynote lectures at prestigious national and international events including International Conference on Pharmacy and Pharmaceutical Science, Seoul, 2017, Parenteral Drugs Association, Berlin, 2017 (Ball); International Nursing Symposium, Riyadh 2019 (Bond); 1st International Conference on Environmental Factors and Public Health, Guangdong, China, 2017 (Chen); 27th American Peptide Symposium, Whistler, Canada, 2017, 34th European Peptide Symposium Leipzig, 36th European Peptide Society Symposium, Dublin, 2018: (Howl); 9th Biennial Orthopaedic Nursing Conference, International

Collaboration of Orthopaedic Nursing (ICON), Hong Kong, 2016 (Jester); 36th European Peptide Society Symposium, Dublin, 2018; FinMedChem, 2018 (Jones); World Inflammation Congress, London 2017 (Kirkham); World Orphan Drug Conference, Barcelona, 2017 (Wang).

4.6.6 Refereeing Academic Publications or Research Proposals

All RIHS staff review grant applications for national and international funding organisations and/or research articles for journals. Indicative exemplars of funding bodies include Biotechnology and Biological Sciences Research Council (Dunmore; Goggolidou; Moore); Brain Research UK (Warr); Childhood Cancer and Leukaemia Group (Warr); Economic and Social Research Council (Lim); Engineering and Physical Sciences Research Council (Tang); EU Horizon 2020 (Goggolidou); European Respiratory Society (Kirkham); Marie Sklodowska-Curie COFUND (Moore); Medical Research Council (Chen; Dunmore; Moore; Warr); NIHR (Brookes; Chen; Pillay); Prostate Cancer Research (Matheson); Rosetrees Trust (Warr); Royal Society of Chemistry (Moore).

Examples of journals for which peer review has been conducted include Audiology and Neuro-Otology; BMJ Open; British Journal of Clinical Pharmacology; Dementia; International Psychogeriatrics; Journal of Advanced Nursing; Journal of Alzheimer's Disease; Journal of Molecular Medicine; Journal of Neuroscience; Journal of Neuro-Oncology; Molecular and Cellular Biology; Patient Education and Counselling; PLoS One; Scientific Reports.