Institution: University of Roehampton

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

1. Unit context and structure, research and impact strategy

The Health Sciences Unit in the Department of Life Sciences is a thriving community of 20 (19.5FTE) researchers who seek to understand and promote the key factors that support healthy living and tackle health inequalities. We conduct research that addresses the whole individual, incorporating physical, mental and social well-being, and the environmental factors affecting health. We are invested in the study of homeostasis and both external (social) and internal (physiological) systems of regulation. Led by neuroscientist **Opacka-Juffry** until 2018 (1999-2020), the unit is now directed by psychoneuroimmunologist **D'Acquisto** (joined 2017), to expand an interdisciplinary programme of research on healthy living, bridging neuroscience, immunology and psychology. Our integrated research programmes focus on the body's functions, the mind and behaviour across: c*ell biology and immunology; biomechanics and human morphology;* and *physiology, nutrition and metabolism.* At the time of REF2014, the unit had sustained a focus on translational research, whilst expanding beyond neuroscience to include cell biology & microbiology, biomechanics, and the regulation of metabolism. Our strategic ambition was to continue to invest in these research areas to address urgent and important needs within society; to develop high quality internal and external collaborations; to further increase the involvement of the end users of our research; and to fully integrate research students into the research environment.

Our strategic ambitions have been realised through sustained investment and increased translational capability, strengthening of our international cooperative outlook, and collaboration with academia and industry to address urgent health priorities in society. Our investment in staff is demonstrated by the 14 new staff recruited since 2013, resulting in the growth of the submission from 10FTE to 19.5FTE. This expansion has resulted in a four-fold increase in the total number of outputs (from 89 to 384 peer-reviewed publications compared to REF2014). We have also expanded our funded, formal partnerships with nine HEIs, and have collaborated with over 100 HEIs across the UK, Europe, North America, Australia and Asia to produce research outputs. We have effectively engaged research users in the design of our projects, demonstrated by a wide range of knowledge exchange collaborations with private companies and governmental organisations, including nine industry collaborators and a further eight industry funders. We have successfully expanded and integrated our doctoral community into our research culture, increasing the number of completions since 2014 to 18 (a 98% increase when compared to REF2014) and a current cohort of 19 students. Our expansion, and the successful delivery of our research strategy, have been fuelled through, and recognised by, a concomitant growth in external investment in our research, which has increased three-fold since REF2014. Our investment in new staff has served to consolidate our expertise across the core areas of our research:

Cell biology and immunology (**D'Acquisto**, **Busch**, **Calle-Patino**, **Esposito**, **Opacka-Juffry**)
Our research into cell biology and immunology builds on the work of neuroscientist **Opacka-Juffry** and her investigation of experimental models of human brain disorders, and the neural effects of Novel Psychoactive Substances (NPS, formerly 'legal highs') since 2013. The addition of **Busch** (joined 2013), **Esposito** (2015) and **Calle-Patino** (2013) extended our expertise in molecular and cell biology in health and disease, by adding a focus on translational medicine, in particular molecular mechanisms of chemotherapy resistance, inflammation, cancer and autoimmune diseases. **D'Acquisto** (2017) has expanded the interdisciplinary scope of our health research, working across neuroscience, immunology and psychology.

Biomechanics and human morphology (**Betti**, **Diss**, **Greene**, **Mian**, **Strike**, **Tillin**)
Strike and **Tillin**'s long standing research into mechanisms controlling gait and movement has led to the design of novel approaches to limiting the damage imposed by a sedentary lifestyle. We have also invested in staff who focus on ways to maintain healthy living for the whole body over time and in different environmental conditions. **Mian** (joined 2016) and **Greene** (2016) were recruited to expand the work on injury and rehabilitation led by **Strike** and **Tillin**, and to investigate gait and movement patterns in clinical populations, building on long-term work by **Diss**

investigating age-based biomechanics. **Betti**'s (2014) research has added novel insights into skeletal morphology, and particularly the birth canal. In addition, her interdisciplinary research provides a unique perspective on the role of the environment in healthy living by exploring how climatic factors have historically influenced the way humans gather food for their survival.

Physiology, nutrition and metabolism (**Behrends**, **Corona**, **Costabile**, **Halsey**, **Hauge-Evans**, **Hurren**, **Mackenzie**, **Patterson**, **Trangmar**, **Tyler**)
Tyler's research focuses on the environmental factors that influence brain and limb haemodynamics, and **Trangmar** (joined 2015) has broadened existing research into the physiological mechanisms of physical performance. To expand our research in the fields of physiology, nutrition, and metabolism we recruited **Mackenzie** (2015) for his expertise in muscle metabolism and insulin resistance; **Hauge-Evans** (2015) for her research on pancreatic beta-islets and their role in diabetes; and **Hurren** (2017) for his research on the role of adipose tissue in glucose metabolism. We recruited **Corona** (2014) because of her specific expertise in analytical biochemistry. **Behrends** (2014) and **Costabile** (2015) have widened the scope and impact of the whole group by exploring the role of both good and bad microbes, including gut microbiota, in the regulation of metabolism, neurogenesis, infection and immunity. **Patterson**'s expertise in appetite regulation has led to cross-unit (**Strike**) investigations into the prevalence of overweight/obesity in adults with lower limb amputations. **Halsey**'s research is interdisciplinary within the themes of behavioural-physiology and energy expenditure of humans and animal species.

Interdisciplinary Research
Interdisciplinary collaboration is at the heart of the Unit's research culture and is developed through discussions at departmental meetings, research symposia, University-wide sandpit events, and the work of individual staff who see opportunities for collaboration. Interdisciplinary research is prioritised through the targeted deployment of internal seed-funding and development funds, and the consolidation of collaborations through cross-disciplinary supervision of research students, supported by VC's scholarships. Our collaborations build on a successful track record of developing interdisciplinary research impact with the Centre for Dance Research at Roehampton on promoting health benefits for people with Parkinson's Disease, an Impact Case Study in this Unit in REF2014, which has extended its reach to arts organisations, ballet and contemporary dance companies and independent dance artists internationally since then. Our proximity to colleagues in anthropology, psychology, and zoology has catalysed novel investigations of the influence of homeostatic thermoregulation on a wide range of physiological functions, from the immune response to infection through to the regulation of appetite and energy sources. For example, **D'Acquisto** and **Halsey** have collaborated on the effects of temperature on river ecosystems (Ecology: Perkins, Robertson; Animal behaviour, Psychology: Perna) and on metabolism and thermoregulation in wild Barbary macaques (Animal behaviour, Psychology: Semple). The results of these studies have expanded our understanding of temperature as a common tuner of evolutionarily conserved core mechanisms regulating health in diverse organisms. Similarly, investigations of gait and nutrition in humans have inspired collaborative research by **Halsey** and **Strike** on the mobility of lean vs fat king penguins, whilst **Strike** has also collaborated with colleagues (Psychology: Dyall and Gibson) to explore the impact of multinutrient supplementation on cognition and mobility in able older subjects.

Approach to impact
Since 2014, we have focused on engaging diverse research users to shape our research and guide our dissemination strategies. We have sought to inform *public health and policy*, engage in collaborative *industry-led research,* particularly with organisations that are invested in addressing health inequalities, and work with *clinicians and practitioners* to support improvements in health provision. Our impact has been supported through dedicated workload allowances, pump-priming resources, and sustained engagement with identified research users. We will continue to use these mechanisms to extend our impact, aligned to core research themes.

We combine academic excellence with social awareness of health challenges, to produce research that has implications for *public health and policy*. Our Impact Case Study based on **Opacka-Juffry**'s work on the interactions between NPS and their biological targets illustrates this,

contributing to reclassification of these drugs as regulated substances. **Opacka-Juffry** was awarded a Royal Society Pairing Grant to support a residency with the Home Office Drugs and Alcohol Unit for knowledge sharing with civil servants. **Costabile**, funded by Coeliac UK, the Nutrition Society and the British Dietetic Association, has investigated the accessibility of gluten-free food in terms of financial costs and in-store availability, research which has been used by professional bodies (British Dietetic Association, British Specialist Nutrition Association) to influence government policy. In 2018, the Department of Health and Social Care retained 'GF breads and flour mixes' on the prescribed foods list, such that these items remain available on prescription throughout England.

We engage in a wide range of collaborative *industry-led research* with external companies that tackle health challenges and prioritise social impact. Our Impact Case Study based on **Tyler**'s work with the world's largest sportswear company exemplifies this approach, underpinning the collaborative design of a cooling hood which safely optimises performance in environmentally challenging conditions. In the context of new technologies and emerging health issues, a collaborative project between **Mackenzie**, MediWiSe and King's College London has led to the development of an innovative medical grade device designed to measure blood glucose non-invasively (GlucoWise). We are also actively exploring opportunities to commercialise our intellectual property in collaboration with industry partners, for example, by building industry collaboration around our first patent which was granted in November 2017 (UK Patent Number GB 2493313), for the use of Kissorphin peptides in providing therapy for neurodegenerative diseases such as Alzheimer's and Creutzfeldt-Jakob's. We continue to actively seek industry collaborations with organisations that align with our social impact mission to develop commercial products that support healthy living.

We strive to sustain a research culture where researchers, clinicians and practitioners are brought into dialogue to identify key research questions and research-led interventions in support of health outcomes. Collaborations include **Strike** and the Sport Surgery Clinic in Dublin, Ireland on the study of athletic groin pain, the results of which were published in the *British Journal of Sports Medicine* and disseminated through a podcast and a link to videos on how to perform the associated recommended exercises. **Mackenzie** works closely with NHS England's National Diabetes Prevention Programme to improve our understanding of the differences in metabolism of pre-diabetes and overt type 2 diabetics, and to improve practice and reduce diabetic-related costs to the NHS. **Costabile** (with Jeanes and Reeves) collaborates with NHS consultants (Dr Muhammad Humayun, Professor Janusz Jankowski) on gluten-free diet as the treatment for coeliac disease and (with Jeanes, Reeves) with the NHS, funded by a Dr Schar International Nutrition Award, on research revealing that telephone clinics have a positive impact on dietary knowledge and adherence in adults with coeliac disease. **Strike** also collaborates with the charity Limbpower, on the translation of research to amputees through targeted communication and outreach activities to improve behaviours to support health.

Open research

The Unit has substantially increased our rates of open data provision, and of gold open access publishing. 51% of our submitted outputs are 'gold' open access, while 45% are 'green' open access. 59% of the submitted outputs are available as full texts through PubMed central, while the vast majority are cited in the PubMed database. Researchers follow the UK Policy Framework for Health and Social Care Research. Our studies are registered to platforms such as International Standard Randomised Controlled Trial Number (ISRCTN); ClinicalTrials.gov Identifier (NCT number) and the European Clinical Trials Database (EudraCT). Examples include the Dietary Fibre and Chromium Picolinate (DFCP) efficacy in overweight and obese women trial (Clinical trial number NCT04250831) or the Vemiko VMK223 Study (Clinical Trial number NCT04267731). The results of studies are accompanied by open data where possible, as in the case of the 16S rRNA gene sequencing reads of a study on the impact of lignans in oilseed mix on the gut microbiome. Our IP policy encourages innovation and sharing of discoveries arising from research, for example in providing licensing for open-source models where there is a significant social impact.

Our open research plans relate to samples, analytes, biometric measurements and other human data we collect. We are in the process of gaining a Human Tissue Authority license that will allow us to store, process and distribute tissue and cells collected from our studies, permitting us to establish our own biobank of samples that have been collected for research, which can be shared openly. **Costabile** is establishing a collection of DNA libraries of human and animal microbiota generated in her collaborative work on gluten intolerance and coeliac disease. Access to these samples will allow gastroenterologists and clinical nutritionists to better stratify and treat coeliac and gluten-intolerant patients based on their unique microbiome profile. Samples of serum, muscle and adipose tissue of young and old people subjected to aerobic exercise have been collected by **MacKenzie** and **Hurren** and will be used to identify age-dependent biomarkers of human physical fitness and resilience, a stepping-stone for the identification and testing of novel therapies that tackle ageing-related conditions such as fatigue and frailty.

Research integrity

The Unit is committed to maintaining the highest standards of research integrity and rigour. The Department of Life Sciences operates a sub-committee of the University's Health and Safety Committee, which oversees clinical trials and research activity that involves the public. In addition to Good Clinical Practice training, investigators must be trained and certified by the Health and Social Care Information Centre in information governance. All data are handled in accordance with the Caldicott Principles to safeguard confidentiality. All studies are approved by either the Research Integrity and Ethics Committee or National Health Research Ethics Committees across the UK to safeguard the rights, safety, dignity and well-being of research participants. In considering ethical issues surrounding research, we follow the guidelines of professional bodies or scientific societies, including the Declaration of Helsinki (7th ed), British Association of Sport & Exercise Science, British Neuroscience Association, British Pharmacological Society, British Psychological Society and The Physiological Society. Conflicts of interest are identified and declared in ethical and participant documents, as well as in subsequent publications and presentations. Studies based on experimental animals are run under the guidelines of the Animals (Scientific Procedures) Act 1986 and all the experimental procedures are authorised by licences granted by the Home Secretary. Staff are committed to the principle of the "3Rs" and abide by the rules set by the ARRIVE (Animal Research: Reporting of In Vivo Experiments) guidelines. The University holds a Controlled Drug License to enable research utilising Schedule 1 drugs.

Strategy and vision for the future

Driven by the University's Research and Knowledge Exchange strategy, our research in the coming period will seek to identify new ways to maintain homeostasis. We are particularly invested in interrogating how changes in behaviour and lifestyle can impact health at a cellular and molecular level. We aim to widen the scope of our investigations from the individual to communities, in particular through increased collaborations with colleagues in Arts, Social Sciences, Education, Law and Humanities, further fostering interdisciplinary investigations into healthy living. The integration of staff in the University's new Nursing provision, and the development of their research capacity and culture, will be key to the future sustainable growth of the unit and will offer opportunities to consolidate our focus on health in the community. Our Local Authority engagement will create opportunities for the co-production of novel approaches to healthy living between researchers, public health practitioners and industry partners and we will proactively engage with companies and individuals involved in research associated with healthy living in order to increase and diversify external investment in our research. A specific focus here will be on developing an active portfolio of Knowledge Transfer Partnerships and industry funding which builds on our established working practices, such as **Costabile**'s recent collaborative study with Optibiotix Health to test the anti-obesity effects of 'SlimBiome' - a pre-biotic that fosters the growth of beneficial microbes - in a collaboration which is currently producing a portfolio of innovative ideas that could help the company to achieve its goals. Finally, we will broaden the diversity of staff and postgraduates, in alignment with our already highly diverse undergraduate body, through targeted appointments, particularly through the creation of new ECR opportunities including Postdoctoral Fellowships and Lecturer roles, to support inclusive research cultures and participation in STEM. Our Research and Knowledge Exchange Strategy was designed and launched prior to the effects of the global pandemic but we remain committed to its delivery, and

we will take advantage of the opportunities afforded by new practices, such as virtual research seminars, developed during the period to extend the reach of our work.

2. People

Research support and staff development

Our research strategy has been to maximise the opportunities available to all staff to realise their individual research potential, and to develop and disseminate research of the highest standard. This has been achieved through the protection of research time, the fostering of an inclusive and dynamic culture within which to build collaborations, and the provision of effective support and development systems.

All staff returned to this Unit are on permanent contracts. Staff with a significant responsibility for research are allocated research time through a comprehensive workload model, with allowances of up to 40% for research, and additional allowances for the development of impact and large-scale bidding and grant capture. Further short-term, concentrated, research time is scheduled through timetabling for specific activities such as research collaboration visits. For all eligible staff, including those on part-time and fixed-term contracts, research allowances are enriched with a rostered sabbatical term, available every three years, which has supported the preparation of major publications or research grant applications (20 taken since 2014). ECRs also have a protected reduced workload for their first year and accelerated access to rostered sabbaticals. Our strategy ensures that all ECRs have access to research leave, allowing them time to work on current research and to develop future plans, whilst they can also participate in the Early Career Academic Network which runs seminars with themed sessions on areas such as publishing, bidding and impact.

Staff development has been a central focus since 2014. Staff appraisals are carried out annually, with research plans for the upcoming year and more extended periods discussed and agreed. All staff have a research mentor (Reader or Professor), with whom they meet regularly. In addition to their line manager (PI), postdocs also have a research mentor allocated, to provide support independent of that work. Mentors identify training and other needs and facilitate staff development. In-house training is provided for a wide variety of research-related work, including bidding, project management, impact development and knowledge exchange. Provision is also made for bespoke training, funded through staff development monies. Successful competitive bidding for internal departmental funding provides support for a wide range of initial pilot studies, as well as seed-funding for impact related activities. Travel and conference attendance is supported by a stipend, with ECRs and new colleagues prioritised in the distribution of these funds, whilst workloads are managed flexibly to support conference attendance for those with caring responsibilities. Fixed-term and part-time staff are supported through the same mechanisms as all staff, and both workload and progression are facilitated on a pro-rata basis in terms of expectations.

Our reward for research performance is primarily delivered through promotion, which is benchmarked against clear expectations for academic roles. Our investment in staff development has enabled the promotion of colleagues internally since 2014, including **Halsey** to Professor, **Costabile**, **Strike** and **Tyler** to Reader, and ECRs **Behrends**, **Corona, Greene** and **Trangmar** to Senior Lecturer. We promote the exchange of staff between academia and appropriate professional contexts through the flexible use of sabbatical time, the ability to reduce FTE of individual posts, and the use of honorary fellowships. We also have mechanisms to support those entering higher education, through the provision of a year-long Professional Development Allowance, which can provide dedicated workload allocation of up to 30% to support the transition to a research career.

Staff recruitment

The significant investment in staff recruitment (14 new staff since August 2013) has been pivotal in the success and growth of the Unit. Throughout the period we have focused investment predominantly at the early and mid-career levels, and on researchers with a proven track record

of interdisciplinary work who complement our expanding portfolio of expertise. All new staff are supported through their probationary period with clear objectives in relation to research, and additional workload allocations to support their integration into the Unit. Meetings with research mentors and line managers support probation.

We recruit new staff strategically, with a view to new research collaborations. For example, collaboration between **Esposito** and **Calle-Patino** has secured a John Goldman Fellowship and Cancer Research UK funding, respectively. Their collaboration and integration into the Unit has been encouraged through two institutionally-funded PhD studentships (Mariacristina Ciccoli and Antonella Di Mambro) which resulted in the development of a system for high-throughput screening and repositioning of clinically approved drugs for their therapeutic potential in the treatment of leukaemia. The team's work has led to an early career grant award from the British Society of Haematology to **Esposito** for her collaborative research with **Calle-Patino** on the role of the tumour microenvironment in the progression of mixed lineage leukaemia. A similar success involves **Hauge-Evans**, who was awarded a Diabetes UK RD Lawrence Fellowship and the University provided her with a fully-funded PhD studentship (Nirun Hewawasam) for research on pancreatic beta cell and islet functions, to which **Patterson** has contributed his expertise in metabolic homeostasis. **Hauge-Evans** has worked with **Corona** and **Costabile** on the interactions between diet, gut microbiota and islet function in type 2 diabetes, a novel project which attracted further funding from Diabetes UK. This team has also collaborated with **MacKenzie** and **Hurren** to study tissue-to-tissue communication between muscle, liver and pancreas following feeding and/or exercise, in the context of diabetes.

Training and supervision of Postgraduate Research Students

Since 2014, we have been successful in growing a strong and vibrant PGR community that is well integrated within our research cultures. We currently support 19 continuing full and part-time PhD students, and our 18 successful completions during the period represent a 98% increase since REF2014. We have supported our PGR growth with 14 VC's Scholarships, and have also benefitted from scholarships from Whitelands College (one), and the RUSH scheme (one) to support PGRs from ODA-recipient nations. PGR recruitment is facilitated through open competition for all funded opportunities, which conforms to University policies on Equality and Diversity. PGRs are able to approach the Graduate School to identify appropriate supervisory teams, and are only recruited where projects align to staff expertise and research strategy.

Students' research projects are funded by the BBSRC, Innovate UK, Society for Applied Microbiology, Royal Society, British Society of Haematology, Society for Endocrinology, a range of charities (Multiple Sclerosis Society, Diabetes UK, Coeliac UK, Cancer Research UK, Leuka), CNPq - the National Council for Scientific and Technological Development in Brazil - and the private sector (New Gluten World, Oxford Cannabinoids Technology, BioAtlantis, Wassen, GE Healthcare, MediWiSe). Our PGR research community is enriched by a healthy flow of visiting international research students; a total of 16 summer studentships have been supported by the *Science Without Borders* programme, three from Erasmus+, four from the RISE-DAAD and two by the Faro Fellowship.

Each PGR is supervised by a Director of Studies, an experienced staff member who has previously supervised to completion, and at least one co-supervisor. Complementing University-wide training offered by the Graduate School is local-level training and subject-specific provision. The progress of all PGR students is monitored by a Departmental Research Degrees Convenor, who chairs the Life Sciences Research Student Review Board (RSRB). The RSRB oversees the monitoring and administration of research student progression, supporting timely completion of their studies. PGR students in the Unit are offered training across the Life Sciences, exposing them to techniques and research methodologies across disciplinary boundaries, consolidated through office and lab space shared with students from zoology, anthropology and psychology. PGRs are encouraged to attend events and participate in our research culture. PGRs also benefit from external supervisory collaborations which augment cross-institutional collaboration and research exchange. Since March 2020, we have added further levels of support for all PGRs to help them

through the pandemic, including funded extensions, extra academic and pastoral support when required, and the revision of research topics where necessary.

PGR career development is assisted through extensive collaboration and co-authored publications, career mentoring, dedicated training, and professional networking opportunities, including provision for teaching and training in relevant professional skills. PGRs also develop professional skills through targeted events and activities such as presenting work at our research seminar series. All successful PGR completions have secured positions within one year of graduation, in both industry and academia. For example, Mariacristina Ciccioli and Natalia Bravo-Santano are Senior Scientists at ANGLE plc, Nakul Shah is working at LM Manufacturing as a Quality Control Specialist, Rabia Ahmad is a scientist at GE Healthcare, Naghmeh Nikkheslat is a postdoctoral fellow at King's College London, Uta Drescher is a researcher psychologist in Germany, Muhammad Humayun is a consultant gastroenterologist for the NHS, and Simone Carneiro-Nascimento is a postdoctoral researcher at Harvard Medical School. In order to foster student innovation, the University ensures that IP created by students remains under their ownership, and PGRs are eligible to apply for start-up business support funds.

Equality and diversity

We embed equality, diversity and inclusivity (EDI) in our staffing, research culture, and support mechanisms, implementing University policies and legislation relating to equality, diversity and anti-discrimination. Management, including Research and Knowledge Exchange Leads and Research Mentors, are trained in EDI and implement policies to ensure that recruitment, promotion, sabbatical, bidding and funding decisions are made equitably. Senior staff provide bespoke support on the allocation of duties, timing of work, relief of pressures from internal deadlines and appropriateness of workspaces while the distribution of internal research support funds is always made with EDI in mind, to ensure that individuals' needs and circumstances are considered. PGR regulations now mirror staff support for parental leave. Staff returning from parental and other leave are supported through workload allocations, whilst research sabbaticals are accelerated, taking place in the year preceding, or immediately following a period of leave. Promotion criteria acknowledge periods of parental or caring leave or other personal circumstances through 'pro-rata' expectations for roles. Colleagues with individual circumstances are supported through flexible working (and, where feasible, remote working). We also have structured local rules to support full access to labs, including working out of hours and/or alone, based on rigorous risk assessments and consultation with the Life Sciences Health and Safety Sub-committee. Staff can seek the support of HR and Working Relationship Advisors, and PGRs are also supported by tailored University services (Graduate School, Staff Wellbeing, Student Wellbeing). All staff and PGRs have been offered mental health first aid training in 2020, whilst dedicated research staff and PGR wellbeing sessions have been delivered on mental health.

Our Unit actively promotes inclusive research practices, and this is reflected in the diversity of our staff and students. Our selection of outputs process was conducted alongside equality and diversity analyses to ensure decisions had no adverse effect on staff with protected characteristics. Out of the 49 submitted research outputs, 8% are authored by staff identifying as BAME and 39% by female staff, while no members of staff declared a disability or identify as LGBTQ+. We have strived to be representative across all career levels, with 49% of outputs attributed to Senior Lecturers, 16% to Readers, 12% to Professors and 8% to Lecturers. 40% of our current staff identify as female, 10% identify as BAME, whilst over half come from European countries. 72% of our completed PGRs identify as female and 39% as BAME. Of our current PGR community, 68% identify as female, 26% as BAME, and represent ten nationalities. 5% of both cohorts identify as LGBTQ+. We recognise that significant disparities remain between our PGR and staff communities and are committed to addressing systemic inequalities and diversity in the health sciences more broadly. We have policies in place to support the development of a more representative PGR body and we will create pathways to research for our richly diverse UG students, preparing students for Master's study and beyond, and employing the University's fellowship scheme to further support diversity in research careers. The Unit is also committed to supporting initiatives that promote inclusive research cultures. For example, Mrs Anne Obayiuwana was awarded a *Faculty for the Future* fellowship from the Schlumberger Foundation

for the academic year 2018/19, to work on a project on 'Nigerian wholegrains and cardiovascular health' under the supervision of **Corona** and **Costabile**, whilst in 2019 Dr Shannon Fowler was awarded a three-year £130,000 Daphne Jackson Trust Fellowship, which supports returners to research careers, under the supervision of **Halsey**.

3. Income, infrastructure and facilities

Infrastructure

Research is managed in the Unit by the Research Centre Director; research in the Department is overseen by a Research and Knowledge Exchange Lead who represents the Life Sciences at University level. Planning and daily support of our research activities are assisted by dedicated Research Development and Impact Officers, respectively, who offer discipline-specific support for the development of networks, partnerships and external collaborations, identify national and international funding opportunities, and support public engagement, impact and knowledge exchange activities. Our laboratories and facilities are supported by highly qualified technical staff (5.6 FTE), four of them holding postgraduate degrees (MScs and one PhD). All technical staff benefit from allocated time for further training in specific expertise. They are also integrated into the wider research culture, attending research seminars and internal public events, and are formally recognised in research publications to which they contribute as co-authors. Large-scale data storage needs are supported by the IT department, who facilitate storage in the cloud as required. Data sharing is governed by the University's data protection policy and guidance for researchers provided by a Data Protection Officer and a Contracts Advisor who arranges data sharing agreements where required.

Income

We have made significant progress in expanding, diversifying and increasing sources of external funding since 2014. Total funding of £1,270,209 represents a three-fold increase since REF2014 (£309,764 total income). Notably, in terms of sustainability and future trajectory, the Unit is supported by a range of open competitive charitable funding and by industry, including contract research. Our increased research income and diversity of sources has been attained through support structures that have increased the number and scale of funding applications, whilst focusing on improving their quality. Established infrastructures such as research workload weighting, sabbatical provision and targeted seed-funding have played a significant part in this development, but the assistance of a dedicated Life Sciences Research Development Officer has enabled greater advanced bid planning, strategic priorities and transparency. Bid quality has been improved through rigorous internal peer-review of application drafts by senior colleagues with grant attainment track records. Impact activities associated with received awards have been supported by the Life Sciences-dedicated Research Impact Officer, and collaborations and industry funding by dedicated legal services staff.

The strength of our translational research that addresses society-relevant health issues through unique interdisciplinary projects has been central to our success. Examples demonstrating our breadth of funded research include **Betti**'s project on the impact of human pelvic shape on successful birth delivery (Sasakawa Foundation: £8,950, 2019; Primate Research Institute Kyoto University: £1,245, 2019). Projects funded by industry include the previously mentioned collaboration by **Tyler** with the world's largest sportswear company (£29,505, 2016), the work of **Costabile** with Christian Hansen (£11,070, 2018) and **Busch** with Clasado Biosciences (£28,585, 2016), and the study led by **D'Acquisto** on immunomodulatory natural cannabinoids for Oxford Cannabinoid Technologies (£600,287, 2018). **Calle-Patino** and **Esposito** have received funds to identify new therapeutic approaches for the treatment of Acute Myeloid Leukaemia and Mixed-Lineage Leukaemia (Leuka: £118,902, 2017; British Society for Haematology: £10,000, 2018). **Behrends** and **D'Acquisto**'s research on novel host-directed antibacterial therapies has been supported by the Society for Applied Microbiology (£10,000, 2018), and the Wellcome Trust (£2,000, 2018). The investigation of antigen processing and presentation in autoimmune diseases by **Busch** has been supported by the Multiple Sclerosis Society (£30,250, 2016) and Arthritis Research UK (£53,991, 2014). **Corona** has received funding from BBSRC (£23,543, 2015) for a study on the pharmacological activity of oats on cardiovascular diseases. **Hauge-Evans**' work on

pancreatic islet function has been funded by Diabetes UK (£46,162, 2015). The comparative biology research on behaviour, movement and macro-physiology run by **Halsey** has been supported by the Leverhulme Trust (£87,000, 2015) and DEFRA Darwin Plus (£47,907, 2015).

For successful substantial grant applications, match-funding support is provided by the University to employ a PhD student or a postdoctoral researcher. This policy has been central to expanding our research capacity since 2014, and to supporting successful grant capture. A total of £703,000 has been invested in studentships, fee waivers and consumables for PGR research projects. **Behrends'** study on new ways to foster a stronger host response to pathogens was funded by a New Lecturer Research Grant from the Society for Applied Microbiology. The University's provision of a fully-funded PhD studentship (Natalia Bravo; completed in 2019 with four published papers) has helped the investigators to set up state-of-the-art screening technologies that allow identification of changes in the phosphoproteome and host metabolism following infection with clinically relevant nosocomial pathogens, including Methicillin-Resistant *Staphylococcus aureus* (MRSA). The results of this work have led to the identification of potential new treatments for antibiotic resistance based on previously screened drugs (drug repurposing), as well as collaborations with several other academic specialists (Imperial College London and the Francis Crick Institute) and private sector biotech companies (Christian Hansen). Further successful examples of PhD studentships co-funded by the University and external partners are: Diana-Elena Motei (supervised by **Mackenzie**, **Hurren** and **Behrends**), who worked on a project sponsored by NHS England National Diabetes Prevention Programme, and Fulvia Draicchio, whose work on the non-invasive measurement of blood glucose was supervised by the same team and sponsored by MediWiSe.

Facilities

The Unit has benefitted from investments in state-of-the-art equipment and experimental setups to support our research. A series of investments to facilitate the work of newly appointed staff and to upgrade existing facilities have transformed our research capabilities since 2014. The Unit benefits from a wide range of specialist and basic facilities for biomedical research including four separate rooms with cell culturing equipment including eight safety cabinets, six cell incubators, five inverted microscopes, and a wide range of equipment for proteomics and genomics (LCMS, HPLC, PCR, DNA analysers, Nanodrop, sets for Western blotting) and cellular/biochemical analysis (Flow cytometer, microtomes, microplate readers, contrast and fluorescent microscopes). There is a 70 square meter lab dedicated to class II bacteriological work, which is fully equipped with incubators and fridge/freezers for the storage and growth of bacterial stocks. Our facilities comprise specialist well-equipped research suites - imaging, radioactivity, metabolomic/lipidomic/proteomic, glass gastrointestinal model, human interventions and biomechanics - that serve the research needs of our staff. These facilities have allowed us to carry out studies both *in vivo* and *in vitro,* thus opening the doors to clinical trials and knowledge exchange collaborations with external academic partners and private companies:

The *Imaging Suite* has been created to meet the demand of several new members of staff (**Behrends**, **Costabile**, **D'Acquisto**, **Esposito**, **Hurren**, **Mackenzie).** This holds a Leica-4 colour fluorescent image capture microscope paired with the Neurolucida MBF imaging system. To expand these analyses to live cells, we invested in a Nikon microscope with on-stage incubator and an Evos FL paired with an Ibidi stage heating system. These two systems allow the acquisition of live cell imaging (time-lapse) that can be used to address basic scientific questions and/or to run pre-clinical tests. The availability of this equipment has allowed **Calle-Patino** to gain funding for a drug-repurposing study sponsored by Cancer Research UK. The purchase of an Accuri C6 cytofluorimeter and an Attune NXt from Thermofisher to perform phenotypic characterisation of both eukaryotic and prokaryotic cells has been the catalyst for many of our successful funding applications and knowledge exchange collaborations.

The *Radioactivity Suite* is a designated laboratory for work with radioactive isotopes including ^{3}H, ^{35}S and ^{125}I. It is equipped with a wide range of instruments and tools for radioactivity work with biological samples traced with radioisotopes and has been used in research on interactions between NPS and their biological targets in the brain, led by **Opacka-Juffry**. Perkin Elmer beta

and gamma counters for receptor binding and hormone analysis expand the types of biomedical investigations that we can conduct. The investment in the gamma counter has enabled **Hauge-Evans** to gain funding from the Society of Endocrinology and Diabetes UK (early career grant in collaboration with **Costabile** and **Corona**). This sought-after research facility has also allowed **Patterson** and **Opacka-Juffry** to extend their collaboration with Professor Christopher Pryce at the University of Zurich on the neurobiological and metabolic effects of stress, and gain funding from the CNPq (the National Council for Scientific and Technological Development in Brazil) for a PhD studentship for Simone Carneiro Nascimento.

The *Metabolomic/Lipidomic/Proteomic suite* is a new facility that supports interdisciplinary research. It is equipped with an ultra-high performance liquid chromatography triple quadrupole mass spectrometer (LCMS) LC-(TQ)-MS Waters Xevo TQ-S and a Gas Chromatograph with Flame Ionisation Detector. The facility has supported the work of **Behrends**, **Busch**, **Calle-Patino**, **Corona**, **Costabile**, **Mackenzie** and **Tyler** in a wide range of fields of research - from microbiology to nutrition and physiology, cell biology and drug discovery - supporting more than 20 publications and helping attract external funds.

The *Gastrointestinal Glass Model suite* is a designated area established by **Costabile** to study gut microbiota. The set-up represents anatomical areas of the large intestine and is a useful tool to monitor the microbiome in relation to different environmental conditions, dietary intervention and the administration of drugs. Thanks to this facility, **Costabile** has set up knowledge-exchange collaborations with OptiBiotix Health, BioAtlantis, VeMico, Clasado Bioscience, Friesland Campina Ingredients Innovation and Animal Health Innovation, and Christian Hansen.

The *Human Intervention and Biomechanics suite* has been set up to facilitate research in the areas of physiology, nutrition and metabolism, and biomechanics. The human intervention suite includes a designated room used for a wide range of physiology measurements, blood collection and muscle biopsies. In addition to a phlebotomy chair, ECG recorder and electronic weighing and measuring stations, the lab hosts a Cortex Metabolic Analyser purchased to allow **Hurren**, **Tragmar** and **Mackenzie** to perform real-time measurement of human metabolism and substrate utilisation. In-depth investigations of human muscle biology and architecture have been made possible thanks to the acquisition of a Hitachi Noblus Ultrasound. An environmental chamber with devices for cooling the human body and measuring body temperature facilitates **Trangmar** and **Tyler**'s research on thermoregulation in physical performance. The biomechanics labs have a Vicon motion analysis system with infrared cameras, isokinetic dynamometers for strength testing, the Fastrak electromagnetic motion tracking system and a range of accelerometers, gyroscopes, and integrated sensing units for collecting and integrating biomechanical data by **Diss**, **Greene**, **Mian**, **Strike** and **Tillin**. The full MATLAB suite is available for computational analysis.

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

The Unit's strategy is to work collaboratively with research-users in the origination, design and application of our research. Addressing urgent health priorities in society, we work with patients, carers, academic researchers, healthcare professionals, industry, business, government, charities, educators and publics both nationally and internationally. We continue to cultivate and expand collaborations that support high-quality research, the co-production of research with industry, and community engagement to investigate healthy living and to address health inequalities in diverse communities. The Research Office supports our strategies for international and interdisciplinary collaboration, responding to national and international regulatory frameworks and providing dedicated bidding, financial and legal support. Academic staff have access to financial support to conduct research visits to institutions, industry and partners to develop networks and collaborations.

Our proactive and increasing engagement with commercial companies is core to our long-term strategy. Building on the successful relationship between **Tyler** and the world's leading sportswear company, we seek to identify and develop partnerships that deliver meaningful and sustained outcomes, and generate investment that enhances the student learning experience and progression towards future employment. **Greene** works with Crystal Palace Football Club

providing biomechanics support for female footballers, implementing targeted neuro-muscular injury reduction programmes and monitoring player workloads, whilst also creating opportunities for student placements and internships and pathways to research careers. We also seek to build innovative industry partnerships on a model of co-production, for example, **Strike** and **Tillin**'s work in collaboration with the UK-based company Blatchford Ltd**,** which informs the design and manufacture of prostheses, the work of prosthetists and the health of amputees. This relationship has been supported by a VC's PhD studentship and another externally-funded (Gaelic Athletic Association) part-time PhD student.

Extensions of user-based investigation for industry, health professionals and policymakers include the studies that **D'Acquisto** has set up with Prof Ali Boolani (Clarkson University, USA) and Prof Nick Bellissimo (Ryerson University, Canada) on a major unmet need to address fatigue in health research. The project, sponsored by The Hershey Company, trials how a chocolate-based drink impacts the gene expression profile of immune cells and its relevance to the fatigue-relieving effects of chocolate. Similarly, **Costabile** has been investigating gluten intolerance and a new technology that drastically reduces the immunogenicity of gluten without physically removing it from food. The research has been pivotal for the setting up of an academic SME (supported by H2020 innovation SME Instrument programme, *New Gluten World* [grant agreement No. 732640]) that is now trialling other products such as gluten-friendly beer and snacks. Led by **D'Acquisto**, our partnership with the University of Oxford and a newly established pharma-biotech, Oxford Cannabinoid Technology, aims to identify novel cannabinoid molecules with potential therapeutic effects on the immune and inflammatory response. The results obtained to date have informed innovative anti-inflammatory therapies and also have implications for public health policy. We will continue to build on the policy links established by **Opacka-Juffry** and Davies' (Psychology) extensive networks through the APPG for Prescribed Drug Dependence, to support the dissemination of this research to policymakers.

We are committed to engaging diverse publics and increasing the literacy of health research. Since 2013, we have had over 800 media engagements across national and international publications and broadcasters, including the *Daily Mail*, BBC Radio and TV*, The Independent*, *The Daily Telegraph*, Sky Sports News, *The New York Times*, *South China Morning Post*, BBC Online, *Women's Running Magazine*, and CNN. We also work directly with research users and communities through public engagement. **Opacka-Juffry** has a long-standing partnership with the charity Humankind (formerly Blenheim CPD), benefitting people suffering from drug addiction through the development of an online module called *Meet the Brain*, which fosters awareness of the risks from psychoactive drug consumption, the success of which led to development of a further series of online modules on NPS called *The Brain Toolkit*. The Unit hosts biennial public research days to promote the impact of Health Science research at Roehampton, which are attended by existing and potential collaborators. **Halsey** has delivered multiple talks on energy and fitness at science events for public audiences, including *New Scientist Live*, and *HumaNature* at the Natural History Museum. We also prioritise public science initiatives in the local community in the Borough of Wandsworth, and particularly seek to promote access to STEM with the community of the local Alton Estate. We host *Brain Awareness Week* events annually, as part of the global initiative, and contribute to the *Being Human* national festival, in addition to initiatives such as the *Whitelands College Science Festival* for local schools (**Busch** and **Opacka-Juffry**). Since 2018, staff have contributed to the annual international series of public events, *Pint of Science*, delivering presentations in local pubs. **Corona and Costabile** have also run *Nutrition Science* events for local schools, and we contribute annually to school outreach and public science talks at the Wimbledon BookFest.

All members of the Unit have extended their academic networks since 2014, collaborating with over 100 HEIs across the UK, Europe, North America, Australia and Asia. We build collaborative research through individual networks, invitations to collaborating researchers to deliver seminars and public lectures, and formal invitations to participate in our research cultures through honorary appointments (for example, Professors Pryce and Jankowski have been appointed as Honorary Professors). Significant collaborations with academic partners include those by **Corona** with the University of Reading to explore the benefits of phenolic acids for cardiovascular health. The

findings have led to a successful Knowledge Transfer Partnership with the University of Cagliari, Italy, to study the benefits of traditional Mediterranean diet for health and disease prevention. **Busch**'s expertise in new technologies for measuring the dynamics of HLA tissue antigens has led to collaborations with Dr Mike Deery at the Cambridge Centre for Proteomics and with Professor Mellins at Stanford Medical Center, to examine how HLA protein dynamics are affected by inflammation and nutritional factors, providing insights into gene/environment interactions in autoimmunity. **Behrends** has developed software that is currently being used by the Metabolomics platform of the Francis-Crick Institute. This specialist piece of data analysis software will be released publicly under a joint Roehampton-Crick banner. **Patterson**'s expertise in the neuroendocrine regulation of metabolism added a new direction to collaborative research on the effects of social stress on energy homeostasis with Professor Pryce (University of Zurich) and **Opacka-Juffry**. **Patterson** also contributes to **Hauge-Evans'** collaboration with King's College London, on neuroendocrine regulation of pancreatic islets, and maintains productive research links with the Section of Investigative Medicine, Imperial College London.

Unit members hold editorial board positions on 22 journals, including highly ranked multidisciplinary science publications (e.g., *Scientific Reports*, *Royal Society Biology Letters*) and more specialist research outlets (e.g., *Biochemical Pharmacology*, *Frontiers in Immunology*, *Frontiers in Pharmacology*, *Frontiers in Nutrition*, *Frontiers in Microbiology*). We are also represented on the editorial boards of top journals in our subject fields (for example, *European Journal of Sport Medicine*, *Journal of Functional Food*, *Pharmacology and Therapeutics*). We have contributed 60 presentations and six keynotes/plenaries since 2014, including to the Society for Experimental Biology Annual Meeting, the Extreme Medicine Conference, the International Scientific Association of Probiotics and Prebiotics Conference, the International Society of Biomechanics Conference, the Forum of European Neuroscience Societies conferences, and the British Society of Pharmacology Meetings. Our contribution to the international academic research base has been extended through our work as reviewers for the MRC, Wellcome Trust, BBSRC, ITMO Cancer of the French Alliance for Life Sciences, Fonds de la Recherche Scientifique – FNRS, and the Italian Ministry of Education.

We are also committed to the reproducibility of research and are increasingly sharing with the scientific community the research tools we have generated. For example, newly generated genetically modified mice such as those designed by **D'Acquisto** have been made available through the MRC Harrell archive - the UK node for the European Mouse Mutant Archive. Monoclonal antibodies, bacteria and plasmid vectors are deposited at Ximbio - the world's largest non-profit dedicated to life science research reagents. Where suitable, raw data are deposited in repositories like GEO (functional genomics data), Pride (mass spectrometry data), FlowRepository (flow Cytometry data), PDB (structure data) and Figshare (unstructured data). We have put in place routine procedures that minimise the risks of misidentified or contaminated biological research tools. For instance, the cell lines used in our *in vitro* translational work have all been purchased from the European Collection of Authenticated Cell Cultures and are regularly screened for mycoplasma contamination. Every other year, these cells are sent to Public Health England for authentication using their DNA barcoding authentication service. We are also committed to the dissemination of controversial results that can be challenging to publish, and we were the first to provide evidence for the potential health risks caused by the consumption of gluten free food, due to their lack of important macronutrients like calcium.