Institution: University of Northampton

Unit of Assessment: Biological Sciences (UoA5)

1. Unit context and structure, research and impact strategy

1.1 Unit context and structure

Research within Biological Sciences, maps extensively to the researchers (6.8 FTE) within the Division of Life Sciences with the addition of contributions from researchers (2.2 FTE) within the Division of Sport and Exercise. In August 2019, the Faculty structures within the institution were refined, contributing to further developments in Biological Sciences as a merger into the Faculty of Arts, Science and Technology to create a more coherent and balanced portfolio.

This rebalancing from a Faculty perspective is seen as a positive step with greater opportunity to develop interdisciplinary work and lead the research agenda. Biological Sciences has seen a notable expansion in activity since 2014 and a growing interdisciplinary research culture.
Research staff are affiliated to the Physical Activity and Life Sciences Research Centre (PALS), established in 2017 led by **Kay**, which is a cross-faculty research centre currently containing two research groups. These groups are the Neuromuscular and Musculoskeletal Research Group (led by **Baross**) and the Molecular Biosciences Research Group (led by **Machado** and **Anthony**).

PALS focuses on bringing together researchers examining physiological, psychological and biomechanical aspects of physical activity interventions in sedentary, active and clinical populations, and the microbiological, genetic and molecular aspects of disease progression. Staff within the Molecular Bioscience Research Group fall into four distinct themes which we continue to develop as a unit:

Microbiology

Microbiology research has historically been a strength in the Life Sciences and continues to be an active and productive area. Research is currently focused on two main areas:

- pathogenic mechanisms of infectious bacteria and
- detection and identification of microbial species in environmental and clinical samples.

Current projects include analysis of genetic diversity and function of cell surface molecules in *Campylobacter jejuni*, metal metabolism and regulation in *Streptococcus pneumoniae* and the anti-biofilm properties of natural antimicrobials. Research has also been undertaken on applied microbiology projects including improved methods for detecting microbial contamination of medical devices, diagnosis of antimicrobial infections including MRSA and detailed characterisation of bacterial isolates from deep-seated head and neck infections. Close research collaborations have been established with industrial (20/30 Labs Ltd, GFC Diagnostics), clinical (Northampton General Hospital) and academic colleagues (University of Leicester, Loyola University Chicago).

Molecular Medicine

This is a broad theme combining expertise in gene therapy for rare diseases, skin tissue engineering, molecular orthopaedics and biomechanics in clinical and older populations. Research within this theme is a mixture of basic, translational and clinical research that broadly aims to understand molecular mechanisms of ageing, disease or sports injury and repair and to develop molecular-based interventions and diagnostics. Active projects include the pre-clinical development of RNA reprogramming strategies for spinocerebellar ataxias and exon skipping for Duchenne muscular dystrophy. Collaborations in this area include the Dubowitz Neuromuscular Centre (University College London) and Leiden University Medical Centre, Netherlands. Our

researchers are active members of networks such as the EU-funded COST Action on delivery of antisense RNA therapeutics.

Genetics and Genomics

Research in genetics covers two broad topics: i) Rare disease gene identification using next generation sequencing (NGS) and bioinformatics; ii) Genetics of cardiovascular health and disease. Genomic studies include understanding the role of complex copy number variation and its association with autoimmune and infectious diseases. Currently, studies are being undertaken on host genetics in relation to COVID-19 as part of the COVID Host Genetics Initiative with an international consortium of researchers. Our research involves collaborations with scientists and clinical colleagues based regionally at Northampton General Hospital, as well as nationally and internationally including the universities of Cambridge, Stanford and Harvard.

Bioethics and Welfare

The bioethics and research ethics themes explore the dilemmas and controversies that arise in the biosciences. Topics and dilemmas explored include:

- the ethical dilemmas arising from genetic testing in neonates and adults;
- the ethical dilemmas arising from the use of embryos in embryonic stem cell research;
- the ethics of using human tissue in research and clinical medicine;
- the controversy between altruistic and commercial surrogacy;
- the role and function of a research ethics committee in protecting the public image of science and protecting participants from harm; and
- the codes of conduct that govern clinical trials and finding alternatives to the use of animals in research.

There is a healthy balance of researchers in the Centre including 18 Postgraduate Researchers (PGRs)and 21 academics, of which 9 are included in this Unit of Assessment (UoA) (others are included in UoA2 Public Health). Within the staff included in this unit is a deputy subject leader, two Professors, three Associate Professors, three Senior Lecturers and one Lecturer. As a new area that is developing, we are pleased to already have several post-doctoral researchers on fixed term contracts and this is something that we intend to develop further and provide opportunities for permanent faculty positions. Within the staff submitted to Biological Sciences, **Machado** is the Faculty Research Lead, **Eckberg** is a Bioethicist and leads the Faculty ethics committee. There is a vibrant research culture and collaborations continue to develop with external stakeholders (i.e. Pharmeron, 20/30 laboratories, Northampton General Hospital, Northamptonshire Healthcare Foundation Trust, the Oakdale Group) and other HEIs both nationally and internationally.

1.2 Research objectives

As a relatively new area of research within the University objectives have been measured against institutional objectives set in the PALS Research Centre operational plan and have sought to increase and diversify research and enterprise income generation streams. We are working towards focussing our research in-line with the UN sustainable development goals (SDGs) 3 - Good Health and Wellbeing and 10 – Reduced Inequalities with research that is cross-cutting across all areas.

To provide an environment in which researchers can develop and flourish, providing training and teaching in research methodologies and techniques, developing writing skills in order to disseminate research widely and ensure that this is accessible to those within and outside of academia. It is important that we continue to provide opportunities to collaborate with senior researchers, improving the overall quality of the research that is produced within Biological Sciences. We have developed a robust training and development/mentoring system for all stages of the research career to ensure staff and student researchers are supported/guided towards

developing excellent research that informs their disciplines and teaching. This support includes a mentoring scheme to provide bespoke individual assistance to staff members who have traditionally been more teaching focused. To ensure sustainability both in terms of capacity and financial viability for research the Centre provides peer mentoring and performance & development review (PDR) objectives for researchers. This training is developing a strong research culture in a supportive environment for doctoral researchers and all staff including novice, early career and experienced researchers.

Historically as a teaching focused HEI research has not been fully embedded as a core activity of all academic staff. An institutional commitment to invest in 'Teaching & Research' contracts has provided Biological Science colleagues with additional time allocated to research and scholarship activities. Within the framework of the Faculty of a suite of research objectives has been developed, with all colleagues on 'Teaching & Research' contracts having research-focused objectives via their PDR and a wider goal of supporting more teaching-focused colleagues to become research active. The multidisciplinary Faculty of Arts, Science and Technology structure provides a stronger, consolidated infrastructure for our peer review process, research support, governance, impact enhancement and public engagement,

Over the next five years Biological Sciences objectives are to strengthen research relationships whilst building new regional, national and international partnerships, developing further research excellence through collaborations with external partners. We particularly wish to develop and expand a regional Life Sciences cluster to leverage opportunities across the Oxford-Cambridge Arc. We are expanding clinical studies with local NHS partners and will develop more robust governance structures to achieve this. This will support high quality translational research leading to high quality outputs with a measurable impact. The aim is to expand and diversify income by targeting UKRI priority themes and specific medical research charities having built on specific partnerships, for example by increasing the number of collaborative funded studentships.

Our longer-term goal is to develop a critical mass of academic research activity that will support and underpin the development of a medical school with close links to NHS partners wishing to achieve teaching hospital status. To accomplish this, we are working closely with centre members who are engaged in interdisciplinary research that are been submitted to UoA 2 (Public Health, Health Services and Primary Care).

Our longer-term strategy for 2020 – 2015 is to increase academic staff in this discipline. As a research informed but teaching led institution, we have expanded our portfolio of new taught Bioscience courses which will require further (technical and academic) expertise supporting development of the four themes described above. The expansion of academic staff will provide a succession plan to future-proof research/teaching areas in case a staff member leaves. This expansion will require additional space for laboratories and a proposal will be considered for inclusion in the capital building programme early in 2022.

1.3 Impact strategy

Research staff in the unit work closely with an institutional impact officer to develop their pathways to impact before, during and after the project's lifecycle. Since 2018 a number of impact training sessions have been held to educate staff into considering impact during the conception of a project, through to research activities, publications and follow up to effectively measure impact. Impacts from research can be recorded in our Current Research Information System (CRIS) enabling the linking of relations between projects, datasets, events, outputs and activities. The "impacts" are then able to be made publicly available through our research portal.

Our approach to impact upon the wider community involves a focus in two areas; namely, how a new evidence base may be developed and the development of biological research impact that has clinical utility. For example, innovative practice and research has led to new applications of the InternalBrace, a product in the treatment of soft tissues injuries amongst sports-players, widening the product's reach and providing long term treatment for a new segment of the population

(**Ribbans**). Our second pathway to impact has included research on the neuromuscular mechanisms determining the efficacy of various types of stretching and their effect on athletic performance, range of motion and injury risk. **Kay** has provided a new evidence base and developed methodologies that have been widely adopted by other researchers, and used robust study designs to clarify ongoing neuromuscular, biomechanical and methodological misconceptions reported in the literature by governing bodies, and by the media to influence public perception, clarifying the efficacy of different types of stretching. These findings have been broadly disseminated original research and systematic and meta-analytical reviews in high impact international academic journals and in Position Stands for governing bodies. They have also informed clinical exercise guidance for the NHS and been widely disseminated in the media including the BBC and internationally including the New York Times.

1.4 Interdisciplinary research

Biological scientists have directly collaborated with several other disciplines expanding our interdisciplinary networks. For example, as members of the PALS Research Centre, researchers work closely with staff who across other disciplines. This is achieved by having shared seminars and workshops where researchers from other disciplines are invited to participate, share and develop ideas and concepts. **McCormick** has collaborated with staff in the Faculty of Business and Law to ensure compliance around animal vegan food products. In addition, we have interdisciplinary projects with Computer Science evaluating sensor technology to detect lameness in sheep. We encourage project supervisory teams to have members of staff from different subject areas/specialisms where appropriate. For example, we have clinical colleagues from the NHS that have provided valuable support on PhD supervisory teams particularly for cancer and microbiology-based projects (**Machado** and **Woodacre**). **Lehner** has worked with colleagues in the Institute for Creative leather technology to develop porous gelatin scaffolds for tissue engineering. **Score** has worked with GfC diagnostics, a small company specialising in point of care testing for detection of pathogens including MRSA. **Nasir** has several ongoing collaborations on the genetics of rare diseases, including the Institute of Neurology (University College London (UCL)) and Imperial College. **Anthony** has active collaborations with King's College London and the Dubowitz Neuromuscular Centre and University College London.

1.5 Open research

Staff receive training and support in open access, copyright and data-management. In 2019 the University launched its CRIS (Current Research Information System) enabling greater visibility of not only research outputs, but also research activities and datasets. In 2020 the University purchased a platform for digital preservation, and staff are now moving towards a more open research environment, where open research has progressed from being encouraged, to becoming an integral part of the research life-cycle, including the use of preprint servers, e.g., bioRxiv). Datasets are uploaded to the CRIS on submission, where they are checked for replicability and long-term digital preservation. A strong emphasis is placed on ensuring that our data adheres to the FAIR (findable, accessible, interoperable and reasonable) principles of sharing of data, striving to be as open as possible, but understanding when necessary restrictions are required. To enable this a data management plan is required for all research projects as part of the ethical approval prior to any research being carried out. Staff are encouraged to use DMPonline and examples of well-written data management plans, and one-to-one training sessions are available to all staff.

Staff have been provided with training in the selection of places for publication, use tools such as Sherpa/Romeo and the creative commons to check funder requirements, restrictions relating to copyright, and the selection of appropriate licencing of research outputs. An institutional fund is available to cover the cost of open access where a green (non-payment) route is either not an option, or where the embargo period is extensive. This fund covers the payments for articles, chapters and monographs. Where possible scholarly chapters are made open access. Research activities, such as presentations at conferences, workshops and educational resources are made available under a creative commons licence.

1.6 Research integrity

We fully support a culture of the highest standard of research integrity and rigor conducting research that is ethical, legal and conforms to professional frameworks, obligations and standards. We have transparent, robust and fair processes to deal with allegations of research misconduct should they arise and are detailed in our institutional Research Integrity Policy. Research integrity training and ethical approval processes are integrated into the training programme for postgraduate researchers and are mandatory for the transfer from Advanced Postgraduate registration to PhD candidate status. We work together to strengthen the integrity of research and to review progress regularly and openly. This is reinforced more specifically within Biological Sciences by **Eckberg** having a key role at subject, faculty and university level around integrity and Bioethics. For access to clinical samples, staff apply to publicly available Biobanks. Where clinical samples are collected from NHS providers, NHS ethical approval is sought by working with the NHS Research & Development team and the National Institute for Health Research design service.

2. People

2.1 Staffing strategy and staff development

Since 2013 we have had several promotions within Biological Sciences including **Machado**, **Nasir**, **McCormick**, **Anthony**, **Woodacre** and **Kay**. In recruiting staff, we consider publication records, and whether their work aligns with the strategic aims/themes of the Centre. We assess supervisory suitability and their future research vision during the selection and interview stage. We require a PhD (or equivalent) or near completion, and identify specific research requirements in job applications to maintain and expand the critical mass in specific areas of interest to enable the University to be recognised as a centre of excellence for certain research areas. Staff have Research and Enterprise goals embedded as part of their annual review process. All staff within the unit are on permanent contracts demonstrating the unit's commitment to the University's research agenda and this strategy will continue to be encouraged. Recent post-doctoral researchers have gone on to secure international fellowship positions (i.e. El-Khoury to the Mayo clinic). The institution has an Associate Professor Scheme to support development of current and future research leaders. **Machado** is currently halfway through the scheme, **Nasir** and **Anthony** are new entrants and the PALS Centre lead (**Kay**) was promoted to Professor in 2017 after successfully completing the scheme.

For new academic staff line managers ensure there is a reduced teaching workload compared with members of staff already in post. This allows staff to develop their research vision and apply to external bodies for funding. This is something Group and Centre Leads facilitate by working with the line managers to ensure workloads are carefully managed and scrutinised. We have an institutional commitment to invest in 'Teaching & Research' contracts which have provided all colleagues with additional time allocated to research and scholarship activities on top of the hours already allocated to scholarly activity. The policy for research leave, impact leave and sabbatical leave includes payment of fees (for academic staff undertaking PGR), study leave (25 days) and a flexible approach to timetabling/workloads to allow proper engagement with their research studies.

Retention and reward of staff has been supported by the continuation (since 2011, with an updated scope in 2020) across the University of an Associate Professor Development Scheme aimed at developing the brightest talent with the potential to have a significant international track record in research. Associate Professors are offered mentoring (either from internal or external Professors in related subject areas), CPD and support, for a minimum period of two years. In consultation with the relevant Dean, Research Institute Leader or Director, a suitable mentor will be identified. Typically, the mentor will be internal but can also be external to the University. Where the mentor is external to the University, the relevant Faculty, Department or Institute bears the cost. The role of the mentor is to enable progression and development of the Associate Professor through work towards pre-agreed annual targets during the first two years. Associate Professors are expected

to fully engage in workshops and activities designed specifically for Associate Professors - developed and coordinated by the Dean of Research, Impact and Innovation.

As a new area of research we have strengthened activity by identifying researchers with external collaborations that allow appointment of Visiting Professors or Fellows. For example, where clinical expertise was limited we appointed Visiting Professors (i.e. Agarwal) to support PhD projects. This provides access for the students to clinical multidisciplinary team meetings, to mentor junior staff members and to help with writing manuscripts for publication. We also link to other institutions by some of us within the unit being Visiting Fellows at other institutions (**Machado** and **Woodacre**, Visiting Fellows at the University of Leicester, **Kay** Visiting Fellow at Derby University and Edith Cowan University).

To support early career researchers (ECRs) we provide a mentor scheme (led by **Anthony**) to ensure individuals at the beginning of their research careers are supported and integrated into the unit's research culture. This is particularly relevant for colleagues pursing research alongside their often-intensive teaching or other contracts, and we provide support and guidance for personal and professional development of individuals in this position. ECRs automatically join one of the research groups within the Centre after consultation with the Centre and Research Group leads. Early career researchers play an increasingly important role in supporting PGRs (i.e. in the laboratory). We as a unit fully support the concordat to support the career development of researchers. This includes recruiting, selecting and retaining high calibre researchers with potential for research excellence. We recognise their value, promoting access to professional recognition schemes, and provide opportunities to engage in performance review through our PDR process. We support the career development of our researchers by promoting our centre researcher development programme as well as institutional development activities. We have institutional structures to ensure researchers take responsibility for their own professional development and are pro-active in seeking out opportunities for broader engagement in research though knowledge exchange, public engagement or external collaborators.

ECRs receive centre specific training including regular group and centre meetings with external speakers (i.e. Prof. King speaking on the Richard III project, Prof. Giakas speaking on European funding opportunities, Prof. Behm speaking on neuromuscular responses to foam rolling) enriching the research culture within this unit. Groups provide discipline- and project-specific training complementary to the generic training provided by the Graduate School including specific training on data visualisation, programming in R and training with specialist equipment (i.e. electron microscopy, cryosectioning, kinetic, kinematic, blood and respiratory analyses including isokinetic dynamometry, ultrasound, posturography, 3D real-time motion, electromyography, and reflectance photometry). In addition to the training on specialised equipment and analyses, ECR's can also present and discuss their own research at a monthly seminar series to gain experience and confidence. Experienced researchers also present their latest research in these seminars to enable ECRs to develop a wider understanding of the research ongoing within the Centre, to enable a wider knowledge and understanding of research and to promote the development of collaboration across disciplines.

There is inter-faculty support for staff writing bids including writing retreats. The University has a dedicated Research and Innovation Funding Support (RIFS) team that include bidding and project officers, ensuring that there is support for all stages of the research life-cycle. Staff have access to two data repositories of funding opportunities, dedicated support for bid-writing, project management support and post-award support. Award Management has moved over from a bespoke system to our CRIS enabling additional real time updates including deadlines for bids, milestones for projects and built in monitoring of hours allocated and spent on research projects. This also allows for funding applications to be reviewed by senior researchers prior to being submitted, giving feedback to the applicant and increasing possible successes.

To stimulate and facilitate exchanges with non-academic bodies Biological Sciences encourages exchanges between academic and industrial bodies. For example, we have developed a regional life science forum with dedicated support from The Universities Key Sector and Knowledge

Transfer Manager and working in partnership with East Northamptonshire Council. We also have strong links with the NHS through our Working Together Group between the University of Northampton & Northampton General Hospital Collaborative Meetings and other healthcare providers (i.e. Northamptonshire Healthcare Foundation Trust). NHS staff have been recruited as Associate Lecturers to support and strengthen clinical research and teaching and have been co-applicants of several research funding applications.

2.2 Postgraduate research students

In 2018 all PGRs across the university were relocated to a designated space within the new Senate building to give them a dedicated research suite on campus facilitating a strong sense of community. This is a considerable improvement compared with before where PGRs had limited dedicated space and were isolated across different University locations. This co-location with each other and closer location to their supervisors, laboratories and the broader undergraduate population provides a supportive research culture. Students are provided with funds to support their studies including GBP300 for part time and GBP500 for full time students as well as GBP1,000 Bursaries. This can be claimed once per year, per student to support their research.

Supervisory teams are suitably balanced providing expertise, seniority and a history of prior successful completions. All supervisors must complete the Graduate School run Supervisory Training before they can form part of a supervisory team. On top of this mandatory training supervisors can enrol on the University run Post Graduate Certificate in Research Degree Supervision (PGCRDS) to provide professional development for staff in this area. To date 8 members of the unit have completed the mandatory Supervisory Training and of these, a further 4 have completed the optional PGCRDS. As part of this training staff attend workshops and observe and interview another supervisory team, practice giving written feedback to postgraduate researchers and engage in the pedagogical literature around research supervision as teaching practice.

Within Biological Sciences the majority of our PGRs are self-funding although some have tuition fees waived if they are a member of staff or funding has come from industry (i.e. staff from companies undergoing PGR study have tuition fees and consumable costs covered). We have an extensive programme of structured doctoral support noted in the recent Post-Graduate Research Experience Survey where we were ranked 4th in 2018 and 1st in 2020. This most recent survey includes 1st for overall satisfaction, 1st for resources, 2nd for progression and development and 5th for research culture.

We recognise that within this area that there is additional support required for Biostatistics and Bioinformatics. We provide bespoke training in programming languages (i.e. R/Python) through intra-faculty collaboration. Our centre writing workshops promote enhanced development of writing skills (particularly for international non-native English speakers).

2.3 Equality and diversity

Equality, diversity and inclusion (EDI) are key to staff within Biological Sciences, and all staff comply with institutional requirements and policies around EDI. All staff undertake a mandatory e-learning module on Equality and Diversity as part of their induction programme. Workshops are provided by HR on fair recruitment practice, how to conduct recruitment interviews and unconscious bias training. All interview panel chairs must undertake this training before they can appoint. Staff receive on-going training through faculty away days and colleague-led institutional support and advocacy groups which include a Global Ethnic Majority (GEM) Staff Network, LGBTQ+ group and Staff Disability Network. The University has a Springboard+ (women, trans and non-binary) and a Navigator (men and transmasculine) staff development programme which provides an opportunity for staff to develop themselves and their careers. The University has arrangements that support flexible and/or remote working. In response to occupational health assessments specialist office equipment has been provided, and staff are supported through periods of sick leave and parental leave with phased returns to work and flexible working patterns.

Such periods of leave are taken into account when staff are considered for 'Teaching and Research' employment contracts (which give additional hours for research based on research activity) so no staff members are disadvantaged for taking leave.

Biological Sciences complies with regulatory requirements around equality and diversity, supported by a central institutional Equality and Inclusion Unit and Faculty Equality and Inclusion Champions. All institutional, faculty and centre research policies and strategic plans undergo a formal Equality Impact Assessment (as per our institutional REF Code of Practice), which has proved very positive in enhancing practice and prompting new conversations about equality and inclusion in research. All colleagues participate in mandatory, regularly-refreshed institutional training on equalities and diversities in the workplace. Colleagues regularly participate in workshops on equalities and inclusion within termly faculty staff development days and are signposted to focused institutional training on unconscious bias and other equality and inclusion topics via individual PDR objectives

The demographic profile of the unit is 50 male and 50% female with 20% BAME staff. This is made up female staff - one Associate Professor, two Senior Lecturers, one Lecturer and one Deputy Subject Lead. Male staff include two Professors, two Associate Professors and two Senior Lecturers.

3. Income, infrastructure and facilities

3.1 Research funding and strategies for generating income

As a newly submitted UoA a major proportion of our research income is largely derived from post graduate research fees. We have developed strategies to coordinate applications for funding to prestigious organisations and charities. For example, we co-ordinate applications for small-scale funding for Wellcome Biomedical Science Studentships and have been awarded 12 over the REF period. Research students are encouraged and supported to apply for external travel funds to facilitate their attendance at international conferences. For example, students in the Molecular Biosciences Research Group, have received funding from the Society for Microbiology to present work at annual meetings. We recognise as a teaching led institution that success for larger research funding will depend on collaboration with external HEIs and commercial organisations. Therefore, staff are encouraged to seek visiting researcher positions with partners and currently 20% of staff have visiting fellowships at other HEIs. We have had some notable successes, including **Score** who has secured Innovate Northamptonshire funding working with GfC diagnostics to develop commercial diagnostic tests for infectious disease. **Anthony** has received international funding from the French Muscular Dystrophy Association (AFM) to support a full-time research assistant to work on understanding how Duchenne muscular dystrophy affects the brain.

We have key areas of strength in Cellular and molecular biology as well as applied microbiology. These areas are growing (evidenced by investments in capital equipment, increase in PhD students and pump priming funding success). Therefore, our funding strategy will build on the results of these pump priming awards and PhD projects to develop them into larger translational collaborative projects applying with external partners to major funders including UKRI and charitable organisations (i.e. Wellcome, Rosetrees, Cancer Research UK) as well as applying for funding to work with SME and larger business partners (i.e. through Knowledge Transfer Partnerships).

Bidding targets and income generation is discussed at Performance and Development Reviews (PDRs) and individual research meetings. A system of peer review is in place across the unit supporting colleagues with applications to funders prior to submission. Support for bidding activity and grant management is also provided by the university's RIFS team. Staff are trained in the use of GRANTfinder and Funding Institutional to identify opportunities that are suitable for their level of career experience. RIFS advise on potential partnerships or collaborators for projects in early

development. They support applications to any Early Career Fellowships working out costings, adhering to funders guidelines and obtaining institutional sign-off.

3.2 Infrastructure and facilities

Biological Sciences has two technicians (1.8 FTE) and one Clinical and Laboratory Support Manager (2.0 FTE) that oversee the smooth running of the teaching and research laboratories. They provide general support for academics, PGRs and research staff to run experiments and develop techniques. The unit benefits from a dedicated Radiation, Biological and Chemical Safety consultant to ensure that the unit complies with all aspects of Bioscience related safety and regulations.

Researchers have access to specialist Bioscience laboratory research and teaching space on our new GBP330,000,000 Waterside Campus. This dedicated research space (within the Creative Hub) supports research across the themes identified in section 1. For example, we have a dedicated cell culture facility, and additional laboratories for molecular biology, genetics and microbiology (including cabinets for culturing anaerobic micro-organisms) all of which are category 2 laboratories. In addition, there are dedicated exercise physiology, neuromuscular rehabilitation, and musculoskeletal biomechanics labs in the Sports Science Hub. Institute of Creative Leather Technologies have new state of the art facilities that they have moved into in 2020. This includes advanced imaging (i.e. electron microscopy and fluorescent and luminescent imaging), histology (cryo-sectioning of snap-frozen tissue samples), and chromatography including high performance liquid chromatography and gas chromatography. There are dedicated technical staff that ensure researchers receive appropriate training and induction for use of specialist equipment. Research equipment information is entered into our CRIS (Pure) with details of how staff/students can use the equipment. Procedural risk and Control of Substances Hazardous to Health (COSHH) assessment are securely and safely electronically stored (with version control) and accessible using iPassport software.

We collaborate extensively with research intensive HEIs (University of Leicester, St George's University of London, King's College London, University of Cambridge and Stanford University) to access major research facilities and infrastructure. This includes Next-generation sequencing technology (exome and whole genome sequencing) as well as bioinformatics computing resources and advanced data analysis centres, advanced imaging equipment (i.e. confocal microscopy and flow cytometry), Laser Capture Microdissection, access to Biobank tissue samples and digital droplet PCR technology. This allows researchers to engage in internationally competitive research.

Notable donated items of equipment have greatly facilitated opportunities for research. This has included a Fluorescence Activated Cell Sorter (FACS) for advanced cell analysis supporting PhD student projects. Northampton General Hospital has provided access to liquid handling systems for automated RNA and genomic extraction for genotyping and transcriptomic studies in collaborative R&D projects and imaging ultrasound was provided by Manchester Metropolitan University.

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

4.1 Effectiveness of research collaborations, networks and partnerships

As a small subject area, we recognise the importance of supporting researcher collaborations, networks and partnerships. In recognition of their standing in the Biosciences, staff have been awarded several Visiting Fellowships. For example, **Machado** and **Woodacre** are Visiting Fellows at the Department of Genetics and Genome Science at the University of Leicester and this has led to publications in the areas of bacterial and human genetics. **Nasir** has several ongoing collaborations on the genetics of rare diseases, including the Institute of Neurology (UCL) and Imperial College. **Anthony** is collaborating with the Institute of Psychiatry, Psychology & Neuroscience (King's College London) and the Dubowitz Neuromuscular Centre (UCL). Over 50%

of our research outputs from research involves international partners. **Anthony**, **Nasir** and **Machado** are founding members of the Northamptonshire Life Science Cluster which supports regional sustainability and growth. To promote collaboration with local NHS partners (i.e. Northampton General Hospital) we have a Memorandum of Understanding that supports project development and effective working. All members of the department are members of scholarly societies including the Genetics Society, Biochemical Society, the Society for Microbiology and the Royal Society of Biology. **Anthony** is a founding member of the EU-funded COST Action on delivery of antisense RNA therapeutics as well as its predecessor Action on exon skipping. Participation in these networks has led to high impact outputs and new international collaborations for example with Dr Avale at the National Scientific and Technical Research Council, Argentina and Dr Buijsen at the Leiden University Medical Centre (Netherlands).

4.2 Relationships with key research users/beneficiaries

Members of the centre have worked closely with NHS partners to contribute to Pillar 1 testing in the region. For example, two of our post graduate researchers Young and Brookes worked at Northampton General Hospital (NGH) to develop and implement testing of staff and patients for Covid-19. Our MSc Molecular Bioscience students are now continuing this effort by testing clinical samples at NGH as part of their work placements. A current graduate researcher (Smart) is CEO of 20/30 laboratories and she has redirected the microbiology testing efforts of her company to include COVID-19 testing in the community and the University has provided them equipment to support this effort.

Beyond our submitted impact case studies, there is collaborative research which has contributed to societal impact. For example, research by **Machado** has supported patent applications in the areas of T cell therapy for cancer (T-cell receptor and uses thereof) filed by Cancer Research Technology and work by **Anthony** has supported a patent application (Methods and agents to increase therapeutic dystrophin expression in muscle) filed by Alyson Fiorillo and Eric Hoffman. **McCormick** has developed a research that explored the diet choices that owners were making for their dogs. This work featured as a two-part story within the BBC's The ONE Show, allowing engagement with a wide sector of the public around alternative pet feeding methods and raising awareness of the risks of new diets. As a result, this also identified a potential issue with non-compliance in industry following changes to EU legislation. This was explored directly with the affected companies and led to discussions with the Food Standards Agency about how they engage with companies around supplementation of alternative pet food diets.

The Unit engages with the public and diverse communities in several ways. For example, there are termly Café Scientifique public engagement events (where researchers host public lectures and workshops in a local café). We have organised a sepsis roadshow in collaboration for Northampton General Hospital and Sepsis UK to improve understanding of this disease. **Kay** has conducted an experiment on imagery training and muscle strength for the BBC flagship health programme 'Trust me I'm a doctor'. He has contributed to public awareness and been involved in international news sources, including The Guardian, ABC Life, the New York Times and Men's Health including developing national guidelines in the NHS Choices public website on latest research examining muscle stretching.