Institution: University of Westminster

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

1. Unit context and structure, research and impact strategy

CONTEXT: The researchers in this UoA are based in the School of Life Sciences and the Psychology unit at our Central London campus on New Cavendish Street, Fitzrovia. They combine knowledge of living organisms and biological, psychological, lived experience, and data-led approaches to human health and performance. The researchers undertake interdisciplinary studies to address problems affecting the body and mind. Our overarching theme is healthy living and disease processes. The research spans *in silico* modelling, *in vitro* and *in vivo* models of health and disease through to the study of diverse, and frequently under-represented, populations.

RESEARCH STRATEGY AND RESEARCH GROUPS: Over the current REF period, we have introduced a research strategy that responds to, and moves beyond, the strategy articulated in our REF2014 submission. Our strategy is defined by an ethos of collaboration and, by establishing structures of collective and central support, we seek to support staff in their research endeavours at all levels. We have coordinated our activities within key themes focussing research on Lifelong Health and Wellbeing. We have developed and sustained research centres and groups and expanded our interdisciplinary research capabilities. Over the course of this REF cycle, this focus on themes in areas of existing strength has been accompanied by an increase in laboratory and expansion of our whole-person research. The targeted appointment of a balance of early career researchers and senior researchers (professors) along with a programme of support and career development has enabled us to realise our aims.

Table 1: Research Centres and Groups – UoA3 University of Westminster.

Research Centre for Optimal Health	Develops and implements methodology to define, maintain and promote optimal health in adult life. Uses big data, coupled to machine learning, non-invasive magnetic resonance imaging methodology and development of mitochondrial function-based methods.
Health Innovation Ecosystem (HIE)	Pursues interdisciplinary innovation in health research, integrating life, social and health sciences with new areas of advanced analytics, data science, machine learning, imaging technology and artificial intelligence. The HIE sits across multiple academic structures of the University, including Computer Science and Engineering, Life Sciences and Psychology.
Centre for Resilience	Develops and researches bespoke physical and mental health-related assessments and provides services to external organisations to reduce worker burnout, with a focus on primary care, NHS secondary care and companies. Defined, developed and promoted an approach to social prescribing. Studies food labelling, food safety and functional foods.
Translational Physiology Group	Bridging the whole-person research with laboratory-studies, the research group focusses on environmental stimuli and how these modulate physiology.
Cancer Research Group	Studies the development and progression of solid and blood-borne cancers. Breast cancer survival and dietary consumptions, genome wide association studies, role of DNA damage, post-transcriptional regulation genome instability, identity of new driver genes, cell signalling, micro-RNAs and biomarker discovery.
Tissue Architecture and Regeneration Group	Identification of cellular pathways contributing to tissue remodelling, and regeneration, in the central nervous system damage, epilepsy, the blood brain barrier, amyotrophic lateral sclerosis, liver disease and arthritis.

In REF2014 the former Faculty of Science and Technology incorporated the Departments of Biomedical Sciences and Life Sciences, Psychology, Computer Science and Engineering. This structure enabled significant increase in interdisciplinary work and established procedures for research support. In 2018, the University was reconfigured into three Colleges. Researchers in this UoA are now all based in the College of Liberal Arts and Sciences (CLAS) enabling us to consolidate our existing research activities and to further expand our interdisciplinarity. This has led to the establishment of the Health Innovation Ecosystem, the Centre for Optimal Health and expansion of the Centre for Resilience.

Focussing our research into Lifelong Health and Wellbeing, we have appointed staff researching diverse topics including antioxidants and bioavailability (**Zariwala**) and coping with longer-term health-related conditions (e.g. suicide prevention, HIV, ageing) (**Rosenfeld, Mackenzie**). Our interdisciplinary research expanded following the appointment of Professor **Bell** and **Thomas** from the MRC London Institute of Medical Sciences at Imperial College, who established the Centre for Optimal Health. Other appointments built our expertise in digital communication for healthcare delivery (**Nadarzynski**), while our impact-related activities have strongly benefited from the appointment of our Professor for Public Engagement (**Dartnell**). We recruited colleagues and expanded our staff base in cancer research (**Chen**, **Montano-Hernandez**, **Presneau, Uysal Onganer**), tissue architecture and regeneration (**Coleman**, **Drndarski**, **Haworth**, **Lange**, **Liu, Raheem**), translational physiology (**Deb**), applied biotechnology (**Basnett**), microbiology (**Anyogu**, **Hayes, Mohammed**) and data-modelling (**Gerbault**, **H. Patel**).

We developed new tools and technologies and used these in applications that contribute to our understanding of health and disease. Large data sets such as the U.K. Biobank MRI data (**Bell** and **Thomas**) enabled us to develop liver health indices; state-of-the-art phylogenetic analyses allowed human population movement mapping (**Gerbault**) and the global spread of viruses to be modelled (**Dalby**). Bioinformatic analyses have enabled virulence factors, for example in SARS-CoV-2 (**Lange/Uysal Onganer**) and salmonella (**Mohammed**), to be proposed and computer simulations have been used for drug discovery applications (**H. Patel**). New technologies developed include neutralisation assays with pseudotyped viruses (**Wright**, **McCormick**), drug-affinity interactions at the cancer surface (**Dwek**), genome instability analysis (**Volpi**), new materials for drug delivery/tissue engineering (**Roy, Basnett**, **Zariwala**), 3-D tumour models under flow (**Dwek**) and microbial fuel cells for clean water (**Kyazze**). CRISPR-Cas-9 gene editing is amongst the new technologies incorporated into our work (**Surendranath, Murphy**).

WHOLE-PERSON RESEARCH:
The **Research Centre for Optimal Health** (ReCOH) (led by **Bell**) aims to develop and implement methodology to define, maintain and promote Optimal Health in adult life. At the core of is program is the use of Big Data, coupled to machine learning (ML), non-invasive magnetic resonance imaging (MRI) methodology and development of mitochondrial function-based methods. Since its inception in 2014, the ReCOH has worked closely with academic and industrial collaborators in the UK and the international community. The multidisciplinary team at the ReCOH comprises 8-10 senior scientists and doctoral researchers, includes experts in MRI, ML, mitochondrial function, molecular biology and internationally-recognised experts in human interventional studies. The strategy has been to diversify the funding for the centre beyond the traditional funding bodies (MRC, British Heart Foundation, Innovate UK, The Guy Foundation), and now the centre is also supported by large Industry and SMEs. To date over £5.5M has been directly raised in this manner. In addition, the significant resources (£9.6M) allocated to the UK Biobank (UKBB) allows our team to continue to play a key role in this unique scientific endeavour. The team has actively participated in pan-European consortia (NutriTech, DIRECT), as well as the largest biobank in the world (UKBB), where we lead the Abdominal Imaging section of the Imaging Working Group. In parallel, the ReCOH has worked closely with SMEs (Perspectum, AMRA, Select Research, AInostics, Klarismo, The Health Concierge) advancing novel scientific strategies which have had significant impact both commercially as well as in the scientific arena. Its work with Industrial Partners (Calico, GW Pharma, Herbalife, Pukka, SunTan) is currently developing unique

methodologies to manage Big-Data likely to significantly impact and contribute to the e-health sector, health insurance market and the NHS.

Bell and **Thomas** have been pivotal in establishing MRI as the gold-standard for assessment of body composition in health and disease, as well as contributing to the scientific platform that led to the in-depth phenotyping of 100,000 volunteers in the UKBB, an achievement without precedence in the acquisition and analysis of Big Data at the population level. This program has spawned a rethink of what human biobanks can and should be able to achieve, as well as stimulating both commercial (Perspectum; AMRA) enterprises and large-scale scientific endeavour. Our activity with the UKBB will expand rapidly as it activates the £4M investment recently awarded in an immediately initiated COVID-relevant repeat imaging study, together with an additional £30M for repeat scan of the whole cohort starting end of 2021.

With its industrial partners the ReCOH has been developing mobile applications (apps) for e-health, as well as novel mitochondrial-based systems to assess optimal health at cellular and organ level in human subjects. It has played a central role in the multinational consortium (UK, EU, USA and Brazil) which is moving the field of Quantum Biology beyond its current physics-entrenched base, to a more biological setting, helping propel the field forward, while raising over £800K in funding for this undertaking. Though some are at their pilot stage, these endeavours are already attracting interest from academia and the private sector, especially those associated with the well-being and medical sector, medicinal plants and bioactive compounds (**Booker**) and will become the new gold-standards in their fields, similarly to those that we have previously established for the use of MRI.

The **Health Innovation Ecosystem** (HIE) was established (late 2018) with funding from the university-associated Quintin Hogg Trust (£427K), the Higher Education Innovation Fund and the University itself (£850K). Founded by Professors Chaussalet (School of Computer Science and Engineering), **Bell** (School of Life Sciences) and **Ridge** (Psychology), the HIE pursues interdisciplinary innovation, integrating social and health sciences with new areas of advanced analytics, data science, imaging technology and artificial intelligence. The HIE sits across multiple academic structures of the University, fomenting cross-disciplinary research through joint funding applications, engagement of students in research (e.g. via regular seminars), training courses, and cross-faculty research events. Since the establishment of the HIE, over £1M income has been generated, links have been forged with over 20 external collaborating organisations, research networking events have been organised, attended by over 140 early career staff and students from across all colleges. The cross-college seminar series run by the HEI is regularly attended by over 120 researchers. Events have ranged from cross-disciplinary conversations on health, through to focal topics like sleep, Covid-19 and chronic fatigue.

The **Centre for Resilience** established in 2014 is based at our flagship Polyclinic on our Fitzrovia campus and was established to help individuals, healthcare providers and companies improve individual and organisational wellbeing, productivity, performance and creativity. The Centre receives patients and members of the public in the Polyclinic and undertakes a series of tailored physical and mental health-related assessments. Using this approach, it provides services to external organisations to reduce worker burnout, with a focus on GPs, NHS secondary care and companies. Funded through research consultancies (e.g. the Royal College of General Practitioners), the centre has pioneered working with hard-to-engage groups (e.g. hospital consultants, corporate leaders, men with mental health problems), by applying our cutting-edge research (e.g. **Ridge,** funded by Nelsons, £142K). REFRAME workshops are half-day, intensive resilience-training programmes originally designed to help doctors cope better and perform safely and competently under pressure. ResilienceLab 360 incorporates measures of heart rate variability, psychometrics, and hormones (cortisol and DHEA) to provide participants with data to discuss burnout and building resilience. The programme has been run and evaluated with a range of corporations (Microsoft, OFCOM) and the NHS and continues to have significant impact on well-being in the NHS and corporations, individually and systemically.

There is a long history of **patient-centred research** at Westminster. By adopting a holistic approach to complex health issues, **Ridge, Fixsen**, Visiting Professor Dixon, and former staff members (**Polley** and **Pilkington**) identified that primary care could improve the health and wellbeing of patients with person-centred practitioners. This led to a Wellcome grant (£41K) to define, develop and promote an approach to social prescribing that was subsequently adopted as part of the NHS Long Term Plan published in January 2019. This approach uses frontline professionals to refer patients to a 'link worker', the patient discusses their issues at length, and works with the link worker to co-produce a (social) prescription to fit their complex needs. The team was also funded by 'Make my day better' (£147K) and NHS England (£80K) to develop the National Guidance for Social Prescribing, and Social Prescribing Networks (established across England). Their research has shown that through social prescribing individuals reduce their GP consultations by an average of 28% and A&E attendances by an average of 24%. This approach now forms one of the cornerstones of the NHS system of Personalised Care.

Placing **people and communities** at the heart of our research, work commissioned by the Food Standards Agency (**Draper**) surveyed consumers on the type of front-of-pack (FoP) food labels they found easiest to understand. This established that, of the myriad labels in use, hybrid (multiple type) labels were the best; this finding was adopted by the Department of Health and Social Care and two-thirds of all packaged food and drinks on the market in the UK now sport hybrid FoP labels. The exploration of public perceptions of food safety has fed into how food scares and scandals can be better managed to inform populations (**Draper,** ESRC £7.8K). Research on attitudinal determinants of diet quality and lifestyle of British minority ethnic women in London and in Africa and Asia has led to development of the concept of "Local Food for Global Health". This approach works with communities to develop tailored nutrition for disease prevention (**Tewfik**). Further work on the effects of vitamin D and calcium supplementation on the metabolic and inflammatory profile among pregnant women in Brazil continues to place minority groups at the centre of our dietary research (**Rodriguez**, Science Without Borders, £13.4K; Danish Dairy Research Foundation, £103K).

LABORATORY-BASED, HEALTH-FOCUSSED RESEARCH:
The **Translational Physiology Group** (led by **Elliott**) links whole-person research with laboratory-studies, focussing on how environmental stimuli affect physiology. Studies include the effect of exercise on physiological processes, for example, platelet activation, and hypoxia as a treatment for type-2 diabetes, and research into the effect of extreme environmental conditions on physical performance (**Deb**), the protective role of exercise on aging (**Elliott**) and biochemical markers of heart health during exercise (**Gaze**). The interplay between dietary intakes and supplements on physiology includes work with nano-formulations as nutraceuticals to promote iron absorption (**Zariwala**). Funding has been received from Innovate UK (£35K), Indonesia Endowment Fund (£161K) and Gencore Pacific (£0.5M). A significant impact of this work has been development of a low dose high absorption oral iron supplement; one of the best-selling products in its category in the UK. This group has also developed a first-of-its-kind cellular and mitostasis analysis pipeline ("*MiTye*") to assess medicinal plant and bio-product functionality (**Booker, Bell**).

The agility of staff to quickly respond to emerging threats and global challenges was demonstrated by the development of a cost-effective, portable, battery-powered device to provide in the field diagnosis during the Ebola epidemic (**Moschos**, Wellcome Trust £0.6M). Work in collaboration with the University of Cambridge was carried out to assess a trivalent haemorrhagic fever vaccine against Lassa, Ebola and Marburg viruses (**Wright**, Innovate UK, 0.69M) and rapid discovery and development of broadly neutralizing human antibodies for acute treatment of Ebola infection (**Wright**, Wellcome, £39K). **McCormick** and **Dwek** are developing a prototype lung-on-a-chip as a tool for screening antiviral properties of approved drugs for the treatment of COVID-19; the aim is a model system suited to future viral pandemics (University Health Innovation and Wellbeing research community, £17K).

Further laboratory research in our state-of-the-art facilities includes identification of pathogenic microbes (**Anyogu**, **Hayes, Mohammed**). The use of microbes as tools for the production and development of a range of bio-products and in environmental applications has been extensively

investigated. Polyhydroxyalkanoates as biodegradable polymers for tissue engineering have been pioneered by Professor **Roy** (coordinator EU projects: REBIOSTENT €4.9M and HYMEDPOLY €3.5M) and continued by **Basnett**, previously a postdoctoral fellow now appointed to Lecturer. Environmental applications include the use of microbial electron transfer (METRIS) with microbial fuel cells adapted to clean polluted water (**Kyazze** and **Keshavarz**, British Council, Newton-Mosharafa Fund, £162K).

The **Cancer Research Group** (led by **Uysal-Onganer**) is concerned with the development and progression of solid and blood-borne cancers. The group comprises 10 researchers and 8 doctoral researchers. **Dwek** and **Robertson** lead the DietCompLyf study, the largest U.K. prospective study of breast cancer survival and dietary consumptions, **Dwek** curates and manages the DietCompLyf biobank/database (Against Breast Cancer, £482K). As members of the Breast Cancer Association Consortium, **Dwek** and **Presneau** feed into genome-wide association and transcriptomic studies to identify important breast cancer subtypes. Studies of DNA damage and post-transcriptional regulation have also been carried out (**Surendranath** and **Murphy**) (Children with Cancer £14K). Further work has focussed on genome instability (**Volpi**), identification of new driver genes (**Presneau**), cell signalling (**Chen**, **Montana-Hernandez**, **Porakishvili**) and the role of micro-RNAs in cancer (**Uysal-Onganer**). The team has a track record in biomarker discovery (**Dwek, Robertson**). Through the development of cardiac troponin testing, **Gaze,** with the Association of Clinical Biochemists committee, is developing guidelines for the use of cardiac troponin testing in the field of cardio-oncology. Work on new technologies has enabled deeper insight into carcinogenesis, the development of new cancer models and identification of biomarkers. This groundwork has been supported by external funding and we expect to attract substantial future funding from UKRI, relevant cancer charities, and Biotech interested in testing novel anti-cancer compounds.

The **Tissue Architecture and Regeneration Group** (led by **Lange**) identify cellular pathways contributing to tissue remodelling and regeneration, in response to both physiological and pathophysiological stimuli. **Lange,** an internationally-recognized expert on peptidylarginine deiminase (PAD) mediated protein deimination in the central nervous system damage, showed that extracellular vesicles act as cargo-carriers for PADs in health and in disease. The group has identified markers of epilepsy (**Liu**) and integrity of the blood brain barrier (**Drndarski**). Further work has been concerned with the role of endogenous retroviruses in amyotrophic lateral sclerosis (**McCormick**) (Amyotrophic Lateral Sclerosis Association $327K), the role of inflammation and cell death in liver cells exposed to alcohol (**V. Patel**), melanocortin peptides and natural products (**Getting**, **Locke**) and lipid mediators in inflammation in arthritis (**Haworth**). The Tissue Architecture and Regeneration Group are building on insights from basic research to identify new biomarkers and potential novel therapeutic targets for serious diseases for which there is currently an unmet clinical need, most notably, inflammatory and neurodegenerative diseases. The themes align with the aims of funders including UKRI, medical charities and Biotech.

PERFORMANCE AGAINST 2014 PLANS: Our research strategy in the current assessment period (2014-2020) was designed to build on, and move beyond, our successes in REF2014, in line with the University of Westminster strategy to further strengthen our research by increasing the proportion of staff with significant responsibility for research (SRR), improving the quality and quantity of research outputs and focusing on our areas of research where we make a difference and where our research impact is recognised, valued and sought after. We have more than doubled the number of researchers submitted to this UOA compared with REF2014 and are returning 52 staff. Appointments since 2014 have included four Professors, eight Senior Lecturers, eleven Lecturers, eight Research Fellows, eight Research Associates and a Daphne Jackson Trust Research Fellow. We continue to *grow our researchers from within* and during the reporting period twelve staff were promoted from Lecturer to Senior Lecturer, two from Senior Lecturer to Principal Lecturer/Reader (**Kyazze, Lange**) and a further three to Professor (**Dwek, Thomas, Zariwala**).

Through tailored support and in line with our overall strategy we substantially increased external funding since our last REF submission. In this census period we returned £8.11M to HESA, this

represents a greater than 2-fold increase in our research income compared with REF2014 (average income for REF2014: £0.76M pa; REF2021: £1.16M pa). Our strategy in REF2014 was to diversify our income. We have been awarded funding from the European Research Council programmes, the British Council Newton Fund, UKRI, the Charitable sector, NHS, Innovate UK, and others. See section 3 for further details.

In this reporting period we have published >300 peer-reviewed journal articles, 4 guest editions of journals, >400 conference presentations, >60 books and >140 book chapters. This increase in high-quality research activity has contributed immensely to our research environment and has enabled us to build upon the priority areas identified in REF2014.

Several staff benefitted from Sabbatical Leave funded by QR income to the unit (**Tewfik, Barr, Murphy**) and support for attendance at training courses. These successes result from careful recruitment of early career researchers (ECRs) whom we see as the research leaders of the future as well as professorial appointments to build our interdisciplinary research (**Bell, Dartnell**). This has also resulted from a careful and sustained focus on the research strategy that was described in REF2014. We continued to support initiatives that our colleagues told us were helpful, for example, writing retreats, and implemented clearer processes for funding bid support.

During the reporting period the University entirely reconfigured its research support, amalgamating the research and knowledge-exchange functions into a combined Research and Knowledge Exchange Office (RKEO). This now includes a dedicated Research Development Partner, Collaborations Partner, Community Facilitators and dedicated Impact Officer. Alongside this, a new Researcher Development programme has been established and is overseen by the Researcher Development Working Group, with representation from researchers at all levels (see REF5a).

Research is further supported and catalysed by four University of Westminster Research Communities, established in September 2019, acting as a platform for the research work undertaken across the Institution. The Diversity and Inclusion Community (led by **Dwek**) and Health Innovation and Wellbeing Community are particularly relevant to this UoA and provide internal pump-priming and seed-funding for new impactful research projects under specific themes, thus fostering internal collaboration and interdisciplinary research across the University. Staff submitted in this unit have received funding from both the Diversity and Inclusion and the Health Innovation and Wellbeing communities.

OPEN RESEARCH STRATEGY: Our research strategy strongly emphasises the value of open access research data and publications and attempts to ensure this whenever possible across all its research centres and groups. The University has a dedicated open access fund to which researchers are encouraged to apply (to support publishing via gold OA), supplemented by the College of Liberal Arts and Sciences through QR funding, with green OA enabled by the University's Repository, WestminsterResearch, and Virtual Research Environment. Open access is also built-in at the bid-writing stage thereby ensuring that research dissemination and accessibility are considered from the outset at the research planning stage.

PLANS FOR THE NEXT FIVE YEARS:
Development of our research centres and connectivity with industry: Our ambition is to develop close links with private, public and third sectors through our research and knowledge exchange work. Industry and Employer Advisory Boards have been launched and play an important role in fulfilling this ambition. Schools will supplement the existing Research Director role with a Knowledge Exchange (KE) Coordinator (Dec 2020) who will drive engagement and enable strong levels of impact from our research and KE. Additionally, the establishment of an International Coordinator in each School in the University (Jan 2021) is aimed at maximising opportunities for international collaborations and partnerships that will improve our research reach and density. We will increase support to and promotion of our existing Centres: the Centre for Optimal Health, Centre for Resilience and those being launched this academic year, the Centre for Nutraceuticals and the International Centre for Social Prescribing.

Researcher development: We will continue to "*grow our own*" researchers through targeted support of early career researchers. Our cross-University mentorship scheme will be expanded and refined to operate at College level to support early-stage researchers in a more interdisciplinary way. We will help researchers in their bid-writing and plan to bid for larger programmes, year-on-year. Our mentoring circles initiative (launched in 2019-20) will pay particular attention to equality and diversity in researcher development. Our newly developed University Researcher Development Programme is extensive and has been designed in consultation with School Research Leads and ECR representatives (see REF5a). It launched in October 2020 and covers a range of training under the headings "Impact and Engagement", "Funding for Research and Knowledge Exchange", "Publishing, data, ethics and integrity" and "Taking charge of your career". We expect the development programme to assist further our very positive research trajectory.

Collaborative research initiatives: Building on our current networks of collaboration and partnerships we will drive up the quality, impact and international reach of our research. By 2023 we aim to have doubled the income from research grants - with increments likely to begin after 2019/20 due to the changes in support from the central Research and Knowledge Exchange Office (RKEO). We will fully contribute to the University Research Communities and nurture the emergent research themes across the College and Schools.

Research infrastructure and development of the environment: School and College based research funding will continue to be strategically invested to support work leading to external awards and impact. A programme of matched funding and Centre-based collaborative applications to external funding bodies will increase funding to the unit over the next five years. The School of Life Sciences will continue to invest in capital equipment, doctoral studentships, consumables, conference attendance, and publication costs to underpin our researchers' activities and to support external funding bids. Future funding bids will include, where appropriate, support for technical assistance to improve infrastructure and enable safe use and maintenance of our extensive specialist equipment facilities. We will continue to grow our seminar programme organised by doctoral researchers and will continue to supplement this with research *Colloquia*, continuing to attract high-profile, internationally-renowned speakers and a series of open public lectures to improve public engagement.

IMPACT STRATEGY:
Our impact strategy is based on our commitment to support research that is medically and socially relevant and sensitive to the wider needs of society. Following REF2014 the University of Westminster used its Strategic Research Fund to resource a range of impact-related activities, which enabled researchers to competitively bid for funding for impact work. For example, **Dwek** and **Robertson** were awarded £19.5K for a project with Computer Sciences to develop a PhytoApp to benefit patients with breast cancer. The RKEO also hosts a dedicated Impact Officer with responsibility for facilitating impact activities.

Since 2014 we have supported a range of impact activities, including those underpinning the case studies submitted in this REF. For example, the continued support of the Polyclinic for patient-centred research enabled the establishment of better ways for understanding and ameliorating burnout and depression, including among harder-to-reach men (**Ridge**), and for the development of social prescribing as mainstream NHS healthcare provision (**Fixsen, Polley, Ridge**). We have been proactive in raising the profile and importance of impact in the UoA through workshops and one-to-one mentoring. A series of 'achieving impact' seminars and workshops have been delivered during the assessment period, which have included specific guidance on planning for impact and on evidencing and documenting impact. All research-active staff are required to provide annual, audited impact statements. Targeted financial support for existing and promising impact cases has been provided via the Impact Support Fund, sabbaticals, and School funds to further develop impact-related research activity for maximum impact. These have resulted in the impact case studies presented by this UoA, including the work by **MacKenzie** on Suicide Prevention; **Ridge** on Depression and Burn-out Prevention; **Fixsen**, **Polley** and **Ridge** on Social

Prescribing in the NHS; **Bell** and **Thomas** on Non-Invasive Diagnosis of Liver Diseases; and **Gaze** on Enhancing the Clinical Utility of Cardiac Troponin. The case studies evidence how our research has led to real-world improvements in the care and treatment of patients (**Bell** and **Thomas, Gaze, Polley, Ridge**), as well as wider impacts on societal health (**MacKenzie**).

Potential future impact opportunities are being monitored and nurtured including, for example, diet and lifestyle changes and the impact on cancer survival (**Dwek, Robertson**), tailored foods for optimal health (**Tewfik**), microbes for clean water solutions **(Kyazze),** biodegradable polymers for tissue engineering (**Basnett**) and nano-formulations of nutraceuticals to improve iron absorption (**Zariwala**).

To further support impact generation, we have implemented a dynamic portfolio of external engagement activities (see section 4). These include public lectures (**Dartnell, Elliott**), other public-facing events (e.g., **Dartnell:** Natural History Museum Lates; **Roy:** Tate Modern "Use of Biodegradable Plastics"), engaging with the media, working closely with the University Press Office (**Dwek, Polley, Ridge**); and via regular social media interactions on both the LifeSciWestmin, Psychology and University Twitter accounts as well as contributing to *The Conversation* (**Chong, Elliott, Mohammed, Uysal-Onganer**).

KNOWLEDGE EXCHANGE AND INTERACTION WITH INDUSTRY:
An ambitious programme of Knowledge Exchange (KE) is planned over the next five years. The Clinic@Westminster will deliver CPD to the NHS, Industry, members of the public including Nutrition Advice, Nutrition in Emergencies, Statistics for the diagnostics industry, CRISPR use, Link worker updates, AI and healthcare and many more. This will strengthen the impact of our research and further develop our networks. Our new Centre for Nutraceuticals exemplifies our commitment to translational research, knowledge exchange and societal impact. It has strong industry collaborations and brings evidence-based approaches to product development in this vibrant sector. It will launch in January 2021 with some £500K+ of external funding, two patents in process, two products on the market, two Centre-linked PhD studentship projects and a range of national and international contracts under negotiation.

The Centre for Nutraceuticals will act as a model for our future KE and industry engagement work around product development, contract research and consultancy. The School of Life Sciences is establishing an Industry Visiting Professoriate and aims to have "*industry on the inside*" rather than outside looking in. It will create hot desk space in Central London and work with industry sectors to create industry lecture series, think tanks, reverse mentoring and Live Projects with our PhD students. Our connection to the University's new Incubator project on Marylebone Road will provide an end-to-end route from Lab to point-of-use and we look forward to building impact through this route. A programme of Clinic and laboratory refurbishment and restructure will provide a platform for our research activities and a vibrant place for our researchers to develop and create new knowledge.

2. People

STAFF: We recognise that "*we are our people*". The UoA has put into practice the idea that to develop our research we must support and nurture our people. Our researchers hold important university-wide roles ensuring that we feed into decision-making and implementation of the university research mission. Roles include the Diversity and Inclusion Research Community Lead (**Dwek**), University Research Committee (**Dwek, Ridge**), Knowledge Exchange Committee (**Zariwala**), Graduate School Board (**Volpi**), Researcher Development Working Group (**Dwek**), College Research Director (**Ridge**) and Public Engagement Lead (**Elliott**). Our researchers are active members of staff networks including the BME, Women of Westminster (WOW) and LGBTQ+ networks.

All new appointments have been made in our areas of strategic importance and aligned to research centres and groups so that when researchers join us, they integrate into a supportive environment. We recruited high-quality research staff and grew our research. **Anyogu, Basnett,**

Booker, Chen, Coleman, Deb, Drndarski, Elliott, Gaze, Gerbault, Haworth, Hayes, Lange, Liu, McCormick, Mohammed, Montano, Nadarzynski, Presneau Raheem, Surendranath, Thomas, Uysal Onganer, Zariwala have all joined us since 2014, and we appointed new Professors to develop specific themes: **Bell, Dartnell.** We are pleased that several of our new appointees have been promoted and that two have joined the Professoriate: **Thomas, Zariwala**.

SUPPORT FOR RESEARCHER DEVELOPMENT: All new staff are offered one-to-one support on appointment. They undertake a university-wide induction and, locally, meet the School Research Director and REF unit lead to discuss their research plans and aspirations. New staff are introduced to the leads of the University Research Communities and are encouraged to join community activities. Newly appointed researchers are routinely given a light teaching load for the first semester to enable them to establish their research and to allow them to integrate with the research centres and groupings.

Since REF2014 the University has adopted a workload allocation model (WAM) in which, annually, research hours are directly incorporated into staff timetables as a part of their overall workload of 1504 hours pro rata (250–350 hours for level 1 or 2 research, 425 hours for Readers and Professors), with an additional 174 hours allocated to all staff for scholarship activities. Allocation of WAM hours is linked to the production of high-quality outputs and grant proposals. Staff development needs are identified through annual WAM meetings. Formal applications to the Staff Development Fund for attendance at conferences or specific training are encouraged from staff at all levels, including those on fractional and fixed-term contracts. All new staff members are automatically provided with a start-up fund of £2K and can bid for further funding (£6K-12K) to enable pilot work to be undertaken.

All staff have an annual personal development review (PDR), which allows for reflection and goal setting. The University, as a member of the leadership foundation, has promoted the Aurora Role Model Scheme and the Springboard Program both providing specialist leadership training for our researchers. The College (and previously Faculty) has a defined policy for mentoring and follows the key principles of the Concordat to Support the Career Development of Researchers. This has been supplemented since 2019/20 by mentoring circles where up to eight mentees meet to discuss professional experiences and challenges in a supportive peer group; led by one or two highly experienced senior academics from the College. The feedback from the first mentoring circles has been extremely positive: 93% of the mentee respondents reported that they would like to continue to meet with their cohort for further peer discussions and 93% of mentees said they would be interested in participating in the scheme again.

All staff are encouraged to avail themselves of staff development opportunities. This includes training sessions coordinated by the RKEO on topics such as research governance, ethics, data management, intellectual property, research integrity, media training, alongside compulsory workshops prior to supervision of doctoral researchers and interview training for all those participating in appointment panels. In addition, all researchers undertake relevant subject-specific training, provided by staff in the School of Life Sciences, including, for example, on the requirements of the Human Tissue Act and Laboratory Health and Safety.

We have a defined policy for sabbatical support in the College, which is available to all researchers who have completed three years of continuous service. Sabbaticals are also promoted to staff with individual circumstances who will benefit from help in re-establishing their research, for example following maternity leave. We support approximately one sabbatical per annum, awarded based on defined activity and outcomes. For example, **Porakishvili,** during sabbatical leave, built a consortium of universities in the South Caucasus and successfully obtained funding as the coordinator of the E.U. Tempus programmes for “The development of a curriculum and establishment of a regional training platform for Haematology in life sciences and medicine (DECERPH)” (€0.99M) and “Establishment of Multidisciplinary Innovative Centres for the Development of virtual Laboratories (MICVL) in Biology and Medicine (EMICVL)” (€0.94M). **Tewfik** visited the Harvard School of Public Health and developed a sustainability plan for an

HIV/AIDS public health nutrition intervention in Nigeria and for the dissemination of tailored meals for HIV patients in the Democratic Republic of Congo.

A key aspect of staff development for all researchers is our facilitated "writing workshops" and "bid development workshops" organised by the College. These structured activities are held several times each semester on-site and three times a year off-site (residential) and provide the opportunity, in a conducive and supportive environment, to write and work on outputs and bids. The retreats are run by a trained writing facilitator with staff wellbeing activities incorporated.

We have a detailed College policy on the submission of funding bids. This involves "sponsorship" from a senior academic (Reader/Professor) who evaluates the bid against the funding call and ensures alignment with research groups and/or centres. An internal peer-review process in which two members of staff feedback on the proposed work is a standard requirement prior to the bid sign-off by the College Research Director. Pre- and post-bid support is provided through a dedicated Research Development Partner based in the RKEO. Researchers are regularly invited to attend introductory grant writing workshops if they have had no previous experience of external grant writing. More in-depth "bid clinics" for experienced researchers are facilitated by experts from the Missenden Centre and senior academics in the College provide in-depth group feedback on participants' draft proposals. The RKEO organise meetings that host speakers from, for example, UKRI and Innovate UK to promote funding schemes to researchers. Our annual "employer day" stimulates interaction between researchers and industry (large and small). Through these interactions, researchers have successfully secured Knowledge Transfer Partnerships and consultancy, involving secondment of staff to SMEs (**Thomas**).

To maintain continuity of research activity and leadership we have a clearly-defined strategy for succession planning. Our school structure now incorporates Assistant Heads and we have increased our number of Readers/Professors and continued to promote from within. Retirees have, where appropriate, continued to contribute to our research as Emeritus Professors/Fellows. We aim to nurture early career researchers (ECRs) to ensure that they have opportunities to grow professionally, for example by involvement in doctoral researcher supervision. Normally three fully-funded doctoral studentships are made available to bid for annually; studentships to support the fees of overseas doctoral researchers are also available, approximately two per annum. In the allocation of the studentships, priority is given to ECRs and new staff.

Development of research identities is nurtured through shared ownership of research narratives, groups and communities. Opportunities include the School of Life Sciences weekly PhD and research seminar series, as well as the monthly *Colloquia*, a programme of high-profile talks given by distinguished speakers on research topics of broad interest. The format of the *Colloquia* allows for informal networking over refreshments after the talks, almost as mini symposia. Examples of invited speakers include Richard Oreffo (Southampton) on regenerative medicine, Mark Read (Newcastle) on research impact, Suzy Lishman, OBE, on modern pathology and personalised medicine, Geoffrey Guy (GW Pharma), on taking scientific results from bench to commercial products. Similarly, the Translational Physiology Research group host the Physiological Society Sponsored Seminar Series, since 2017, with 4 speakers per annum including, for example: Ana-Mishel Spiroski (Cambridge), Cameron Hill (Coventry), Lorna Harries (Exeter), Nicola Guess and Thomas Francis (KCL), Naiara Demnitz (Oxford), Marina Ezcurra (QMUL), Claire Nolan (Royal Brompton & Harefield NHS Trust).

DOCTORAL RESEARCHERS: The unit includes 52 doctoral research students (31/7/2020) studying in the fields of anatomy and physiology, biology, applied biotechnology, molecular biology, microbiology, nutrition and pharmacology (including 9 students enrolled on a PhD by Published Work/Professional Doctorate routes). The doctoral researchers share a newly refurbished common office area in two dedicated rooms located close to our research laboratories.

All doctoral researchers are assigned to a research centre or group in the School. Robust procedures are in place to ensure that doctoral researchers are properly supported and expertly supervised during their programme of study. Alongside our on-site doctoral researchers, our

Professional Doctorate in Health Sciences enables cross-disciplinary work often involving medical-laboratory staff undertaking applied research. Researchers undertaking Professional Doctorates similarly engage with Graduate School and School of Life Sciences training programmes.

Researchers are assigned a supervisory team consisting of a minimum of two supervisors: a Director of Studies and a Second Supervisor with relevant complementary research expertise. All supervisors are required to attend the University Doctoral Supervisor Training programme to ensure familiarity with processes and regulations and to support research planning, to help identify specialist training and dissemination strategies and to ensure key academic stages are reached in a timely fashion.

The research proposal, progression reports and MPhil/PhD transfer examinations are assessed by staff external to the supervisory team. Annual monitoring is a formal part of the students' progression through key stages of the PhD life-cycle: from registration to transfer, and completion – supported through an online monitoring system operating at the School, College and University level. All records, for example ethics applications, formal progress reports and outputs for each doctoral researcher, are entered into the online Virtual Research Environment, and progress is coordinated by the University Graduate School (see REF5a).

Doctoral researchers are aware of expectations and individual milestones are established at the outset. Clear processes are implemented to prevent, and where required to address, unsatisfactory performance. Where remedial action is needed this is articulated in a timely manner and solutions determined collaboratively between the doctoral researcher and the supervisory team. In the rare occasion that it may be required, there are clear procedures for escalation of interventions (Annex F framework).

On enrolment, all doctoral researchers join the University's Doctoral Research Development Programme (DRDP), our institution's implementation of the Vitae Researcher Development Framework. This cross-university programme gives the researchers an opportunity to interact with others from their same cohort from Schools across our institution. The doctoral researchers are introduced to the doctoral process and provided with instruction around generic research skills including academic skills; career development and employability; engagement influence and impact. Doctoral researchers are given the opportunity to engage with tailored support to develop further their skill set; new provision includes "academic English", "well-being when writing" and mental health and physical wellbeing. For further details, see REF5a.

To augment the Graduate School provision, a programme of training is overseen locally by the DRDP School coordinator (**Porakishvili**). We run a series of tailored training events for PhD students in Life Sciences, including workshops on public engagement of science (delivered by our Professor in Science Communication, **Dartnell**), knowledge transfer/exchange (**Zariwala, V. Patel**), research practice and compliance (**Murphy, Dwek, Volpi**), Human Tissue Act requirements (introduced by our Designated Individual) with detailed training programme undertaken where appropriate. The Centre for Resilience provides tailored support sessions for incoming doctoral researchers to help them develop strategies for coping with the competing demands experienced at different stages of the PhD lifecycle.

Doctoral researchers have their voice heard through fora run centrally through the Graduate School as outlined in REF5a and locally by involvement in Research Committee and the School Executive Group. Local activities for doctoral researchers include the School of Life Sciences Doctoral Researchers Annual Conference, journal clubs and research seminars. These events provide the opportunity to network, discuss research and showcase work internally. Researchers who have submitted their thesis act as judges during the poster sessions of our Annual Conference. These events also provide a focal point for researchers and support other development opportunities offered across the University such as the Graduate School Annual Reception, attended by external guests and designed to showcase work undertaken by doctoral researchers to the outside world, and the Graduate School Annual Lecture, a networking event

featuring high-profile speakers such as notable alumna Professor Sophie Scott MBE, Neuroscientist and Wellcome Trust Senior Fellow, in 2020. Researchers are also encouraged to participate in the Three-minute Thesis (3MT) Competition, which leads to selection of a University Finalist forwarded for consideration for the National Finals, coordinated by Vitae. As part of the programme of development activities, doctoral researchers are offered the opportunity to gain a Postgraduate Certificate of Special Study in Supporting Learning from the University Centre for Education and Teaching Innovation; this formal qualification recognises supervisory and teaching skills and has been awarded to 24 doctoral researchers in this UoA since its inception in 2015.

A Doctoral Researcher Development Fund is available within the School to support doctoral researchers financially, enabling attendance at national and international conferences during their period of study. This fund also helps researchers to attend specialist training courses. Additionally, the Graduate School Globally Engaged Students initiative has benefited doctoral researchers who are encouraged to apply for funding for participation in conferences (nationally or internationally) and at training courses and workshops to develop and enhance research methods skills. The University 125-Fund also offers doctoral researchers the opportunity to bid for sums of money for consumables and equipment to support their research. Travel awards obtained externally include funding by the Physiological Society for specialist training at McMaster University, Canada.

Awards received at international conferences for doctoral researchers include Best Young Researcher Award at the 15th Global Diabetes and Obesity Conference (Dubai), Best Abstract in the "Young Scientist" Category at the 12th International Conference and 5th Asian Conference on Environmental Mutagens (South Korea) and second-best project idea and presentation at the Climate Launchpad "JSP Waste to Energy: Microworld to Megawatts" competition in 2018.

Recent papers authored by PhD students in the unit as lead investigators (first name) include publications in *Antioxidants*, *European Journal of Pharmacology*, *Frontiers in Pharmacology*, *Frontiers in Bioengineering and Biotechnology*, *Gene*, *Journal of Medical Microbiology*, *Journal of Parkinson's Disease*, *Methods in Molecular Biology*, *Mutation Research*, *Obesity*, *Open Heart*, *Oxidative Medicine and Cellular Longevity*, and *Scientific Reports*. High-profile public engagement initiatives to which doctoral researchers have contributed include the Royal Astronomical Society #reach2019 event and the Natural History Museum Lates series, as well as contributions to *The Conversation* and *Guardian*.

Post-Doctoral employment routes range from editorial roles (Journal Specialist in *Frontiers in Oncology*) and independent consultancies in health and public health to more traditional roles in academia as well as in research and healthcare institutions. Examples of destinations in the UK include the NHS and the National Institute for Biological Standards and Control, examples of overseas destinations include the University of Arizona (USA), the Edward Francis Small Teaching Hospital (the Gambia), and the IPC and Sigma Clermont (France).

ENSURING EQUALITY & DIVERSITY: At the heart of our *Being Westminster* strategy is the intellectual and creative capital of our diverse staff. Our aim is that colleagues are "*comfortable bringing their whole selves to work, where they are empowered, supported, provided with development opportunities and enabled to engage in work they love...*" We consider that addressing issues of equity is simply the right thing to do.

As described in REF5a, the University has committed at the highest level and across the organisation to implementing and evaluating the success of initiatives to build equality, diversity and inclusion across all structures of the university, including our research environment. We are fully committed to the principles underlying the Race Equality Charter, the Athena SWAN Charter and Stonewall, and are proud to have been the first university to be awarded the post May-2015 Athena SWAN Bronze award. We recognise that cultural change comes through the modification of behaviours of staff at all levels and we recognise that intersectionality and a holistic approach is needed to achieve equality of opportunity. We have adopted many practices to foster inclusivity and equality of opportunity within our School and College and are working to implement new initiatives as we continue in our aim to build a fair and equitable research environment.

Several of our researchers are champions for different aspects of EDI. The university-wide Diversity and Inclusion (D&I) Research Community (led by **Dwek**) undertakes research into all aspects of EDI, most recently embarking on a wide-ranging consultation with staff around D&I research at Westminster. Research funded by the D&I Research community covers many aspects and includes work to assess the effect of remote working during the COVID-19 pandemic on diverse groups of staff including researchers. In a collaboration with Westminster Business School, **Dwek** undertook a commissioned report for the Royal Society entitled "Leading the way: increasing diversity in the scientific workforce". **Uysal Onganer** is an Athena SWAN champion.

All researchers are required to undertake an on-line diversity training module. We also require that all staff undertake interview training before they are involved in any part of our recruitment processes. We have implemented our mentoring and researcher development schemes described above to ensure that ECRs as well as experienced staff are supported through their career life cycle. We supported the recruitment of a Daphne Jackson Trust (DJT) fellow. This programme is designed to encourage the return of scientists following a career-break. Her advisor (**Locke**) stated: *"The DJT fellowship provided a unique opportunity to bring an experienced scientist back into the talent pool. The structured and supportive re-entry route enabled her to restart and continue her career. Our research group benefitted from the addition of her knowledge, skills and experience. A very positive experience all round."*

We monitor EDI issues at School and College Research Committees, we work actively to ensure gender parity in pastoral roles. Our policies are designed to ensure equal access to resources for research including sabbaticals, start-up funding, conference attendance and specialist training. Researchers who require extended periods of leave due to caring responsibilities, parental leave or ill health are contacted shortly before their return to the school by a member of senior staff, and plans are put in place to enable them to pick up their research effectively with the appropriate support. We have a system in place enabling researchers to request flexible and part-time working for childcare, other caring or health-related reasons. Similarly, we operate a maternity, paternity and post-adoption leave scheme. We are mindful of the caring responsibilities of our colleagues and ensure meetings, seminars and colloquia are organised within core-hours. Where there is a necessity to host events in the evening, or on the weekend, we ensure that these are advertised with sufficient notice for colleagues to arrange cover.

Our evaluation of the gender balance of doctoral researchers (during the census period) showed that approximately 70% reported as female and 30% as male. The School enrols doctoral researchers from a range of backgrounds and we recognise the deficit of UK-domiciled doctoral researchers who identify as "BAME". To start to address this we have begun work to encourage progression from BSc/MSc taught programmes to doctoral research, both in our own institution and beyond. Whilst recognising the issues with definitions of ethnicity and other protected characteristics, and the difficulties with data capture, we realise that an important aim in the coming period will be to better understand the make-up of those that come to work on research projects with us. We will continue to undertake work in this area, listening to those traditionally under-represented in postgraduate research and will use the information to direct our doctoral research recruitment as well as to gain a deeper understanding of doctoral researcher experiences through every part of the postgraduate research lifecycle.

In preparation for this REF submission, we evaluated the information provided on the equalities monitoring form that staff complete on taking up their appointment at the University. From this we were able to determine how representative this submission was of staff with protected characteristics in the UoA, i.e., those with significant responsibility for research (SRR). There was no significant difference between researchers with SRR in terms of the gender balance (female 54% in this submission v 53% in the whole unit, male 46% in this submission v 47% in the whole unit), or self-reported disability (94% with no reported disability in this submission v 92% in the whole unit). More staff who identified as BME had SRR (31% in this submission v 23% in the whole unit) and there were fewer white researchers with SRR (67% in this submission v 72% in the whole unit). Most of the researchers with SRR work full-time (94%), whilst very are few part-

time (6%). Overall, 22% of the colleagues in the unit work part-time and we aim to improve their representation in subsequent REF submissions.

We trained a group of researchers to evaluate (score) the outputs in this submission. The scorers reflected the gender, age and ethnicity of the researchers returned in this UoA. The outputs were scored in accordance with the guidelines established by the University. We chose the best scoring output from each researcher and the remaining outputs were selected from the "best of the rest" up to a maximum of five named outputs per researcher. In undertaking the final selection, where there were outputs that were equally ranked we selected to ensure that the output pool reflected the researchers in the UOA as a whole.

3. Income, infrastructure and facilities

INCOME: We more than doubled our external funding for research compared with our last REF submission. During this census period we returned to HESA £8.11M from funds that we obtained for research (compared with the £3.8M in REF2014). This vast increase in income follows our intense focus on funding and follows a review of internal processes for funding applications. We streamlined our processes and ensured that we have defined timelines in place for all funding bids. We have a Virtual Research Environment that serves as a portal for project planning from start to finish and for reporting (see REF5a). As described in section 2, our processes are designed such that all researchers, including ECRs, are appropriately supported when bidding for external funding. The requirement for sponsorship by a senior academic has ensured alignment of proposals to the funding call itself, certifying that they fit with school and college priority areas. The requirement for two independent internal academic reviewers means that all bids are assessed prior to their submission. This enhanced support for bid-writing in the College and the University has led to our significantly increased research income since REF2014.

Funding has been secured in all our priority areas and our income streams were more diversified, as had been planned in our environment statement for REF2014. Examples include:

- NHS: What does successful social prescribing look like? **Polley**, £44.7K.
- Medical Research Council: Support for studies of adiposity, **Bell & Thomas**, £1.25M.
- British Council Newton Fund: METRIS: microbial electron transfer, **Kyazze,** £162K.
- European Research Council: HYMEDPOLY, **Roy**, €3.5M, RE-BIOSTENT, **Roy**, €4.6M; TEMPUS EMCVIL, **Porakishvili**, €0.94M & DECERPH, **Porakishvili**, €0.9M.
- ALS Association: HERV-K in ALS, **McCormick**, $327K.

Charities that have supported the research include the Wellcome Trust: Ebola Check, **Moschos**, £0.6M, Wellcome Trust Senior Research Fellowship: Beyond Tradition Styles of Practice and Ways of Knowing in East Asian Medicine, **Scheid** £0.84M. Against Breast Cancer: Research Unit and DietCompLyf Database, **Dwek**, £482K.

Income has also been received from Knowledge Exchange activities including, for example, Calico: Evolution of Enriched-Phenotypes for Health Exploration and Discovery, **Bell** & **Thomas,** £0.57M, and extension £0.99M; Gencor Pacific: Effects of HydroCurc™ on inflammation and iron status **Zariwala** £251K; consultancy work and gifts in kind.

INFRASTRUCTURE: Since 2014 we have invested over £1.77M, renovating our laboratories and researcher offices. We developed a new laboratory for regenerative medicine and GLP level cell culture work, on our Fitzrovia Campus (£1.76M). The new doctoral researchers' office has 40+ desks and the post-doctoral researchers' office 20+ desks near to our laboratories (£144K). We installed swipe access throughout and a Siso Smart Hub and facilities booking tool (£4K).

FACILITIES: We invested >£0.6M in new equipment for research during the census period. All equipment is housed in our purpose-built laboratories on our Fitzrovia campus. This investment has significantly enhanced our research capabilities in key areas and has led to collaborative ventures, as evidenced by our outputs and income, detailed above and in section 4.

We established our Biochemistry Testing Service using a Werfen Ilab Aries analyser (**V. Patel,** £22K) this provides a service for routine blood testing and has gained UKAS accreditation. The Sysmex XP-300 haematology analyser complements this and augments the now very well-equipped physiology testing labs. These house an Individual Hypoxic Chamber (**Elliott** £18K) and the latest Seca mBCA 515 Medical Body Composition Analyzer (£7.6K). These combined facilities generate £20K per annum income for the school. We invested in a new cell line collection purchased from the ATCC (£35K) and re-housed our liquid nitrogen storage facility. Our capability for undertaking metabolic studies was expanded by the addition of a Seahorse XFe24 analyser (**Bell** & **Thomas**, £64K). 3D cell studies are undertaken in our cell culture suite using the Quasi-vivo flow system, Kirkstall (**Dwek**). Cellular analysis with EVOS FL microscopy with a Servomex O_2-CO_2 analyser for real-time imaging studies (gift in kind to **Bell** & **Thomas**, £75K). Nanosight nanoparticle tracking (gift in kind to **Lange** & **Bell,** £22K) for the analysis of extracellular vesicles. Pathology resources include Whole Slide Imaging with Zeiss Axioscan Z1 slide scanner (£66K) and PathXL web interface (£41K). Our molecular biology work has been supported by investment in new q-RT-PCR equipment and protein work has been supported by investment in fluorescent and ECL blot analysis systems (Azure C6001 £38K and UVP, £11K), Trace 1300 gas GC-MS Chromotograph (£50K). A significant investment has been the purchase of BD LSR Fortessa X-20 multi-colour flow cytometer (£166K) used for a range of cellular investigations including analysis of chronic lymphocytic leukaemia (**Porakishvilli, Volpi, Murphy**). Our biomaterials research expanded significantly to include 3D printing, Melt Electrospinning (£35K), Contact Angle Measurements (£9.5K), Differential Scanning Calorimetry (£9.5) and Instron Tensile Testing (£9.6K).

We have invested in a suite of software, including for digital pathology Cirdan PathXL (£12.2K), heart monitoring first beat bodyguard services (£13K) and Covidence metanalysis (£20K). The research laboratories are used for a range of commercial activities as well as TV health programmes. All our resources are open-access and supported by appropriate technical training. We have also accessed other facilities such as HEI shared resources including the Diamond Source for NMR work and the Harwell super microscopy facilities.

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

Researchers in this UoA have a very proactive approach to collaborations within the research base, but also beyond this with wider society and the public through ongoing public engagement activities and close association with industrial partners and public bodies. This strategy reflects the University's intent to become a forum for the creation and interchange of pioneering, disruptive innovations and ideas, between scientists, industrial partners and the public at large. A Professor of Science Communication was appointed in June 2016 to spearhead this work (**Dartnell**). This has enabled us to reach and engage a broader audience, attract substantial funding (described above, section 3) and extend our collaborations and impact in key areas of health and economic growth. We are committed to engaging young people in STEM subjects and health-related studies.

RESEARCH COLLABORATIONS AT NATIONAL AND INTERNATIONAL LEVELS:

National (examples): Aberdeen (**Dartnell**), Bath (**Zariwala**), Birmingham (**Barr**), Brunel (**Volpi**), Cambridge (**Dwek, Robertson**), Cardiff (**Uysal-Onganer**), Coventry (**Zariwala**), Edinburgh (**Dartnell, Smith**), Essex **(Murphy**), Francis Crick Institute (**Murphy, Surendranath**), Harwell Rutherford Appleton Laboratory (**Bell, Thomas**), Imperial College (**Dwek, Montano, Robertson, Uysal-Onganer, Volpi**), King's College London (**V. Patel, Smith, Volpi),** Middlesex (**Porakishvili**), Oxford (**Dwek & Robertson, Ridge**), Queen Mary University of London (**Porakishvili, Ridge**), Queen's University Belfast (**Dwek & Robertson**), Reading (**Zariwala**), University College London (**Dartnell, Dwek, Montano, Murphy, Porakishvili, Presneau**).

International (examples): Feinstein Institute of Medical Research, NY, 2014–ongoing (**Porakishvili**). Kultur University, Turkey, 2016–ongoing (**Uysal-Onganer**). National Research Centre, Cairo, 2018–ongoing (**Barr**). University Hospital Eppendorf, Hamburg, 2014–ongoing

(**Dwek**). University of Zurich, 2019–ongoing (**Murphy**). Staff are also involved in national and international research projects, such as the Breast Cancer Association Consortium (**Dwek, Presneau**), the NCI 'Modifiable lifestyle-related factors and triple negative breast cancer prognosis' (**Dwek, Robertson**), University of Lund, 2016–ongoing (**Bell, Thomas**), Diabetes Unit, KEM Hospital, Pune, India 2018–ongoing (**Bell, Thomas**), University of Debrecen, Hungary 2017–ongoing (**Bell, Thomas**). Harvard T.H. Chan School of Public Health, Boston, MA, USA, (**Tewfik**).

MAJOR CONTRIBUTIONS TO THE RESEARCH BASE:

Membership of Journal Editorial Boards (examples**):** *4OPEN*, *Life Sciences-Medicine* 2018– (**Roy**), *Astrobiology Journal* 2014– (**Dartnell**), *Cancer Science and Oncology* 2019– (**Montano**), *Current Cancer Drug Targets* 2014– (**Dwek**), *Evolutionary Bioinformatics Journal* 2015 (**Gerbault**), *Frontiers in Physiology* 2018– (**Elliott**), *International Journal of Tissue Engineering* 2016– (**Roy**), *Journal of Chemical Technology and Biotechnology* 2014– (**Roy**), J*ournal of the Marine Biological Association of the United Kingdom* 2017– (**Lewis**), *Journal of Visualized Experiments* (JoVE) 2018–2019 (**Barr**), *MDBI - Sports* 2018– (**Elliott**), *Molecular Cytogenetics*, *Thematic Series 'Chromosomal Imbalances in Cancer'* 2017– (**Volpi**), *PLoS1* 2014– (**Dalby**), *Scientific Reports* 2016–2019 (**Dwek**).

Plenary/keynote lectures (examples): Royal Society Synthetic Glycobiology Meeting; Theo Murphy International Scientific Meeting: Bucks. England, 2018 (**Dwek**). International School on Immunotherapy, Tbilisi, Georgia, 2016 (**Porakishvili**). Natural Polymers of bacterial origin and their medical applications, POLYMAR, Athens, Greece, October 2018 (**Roy**).

Conference organisation (examples): International Cancer symposium, University of Westminster, London 2020 (**Montano, Presneau, Uysal-Onganer**). European Cytogenomics Association, Mutagenesis and Toxicogenetics, Salzburg, 2019 (**Volpi**). British Sociological Association Food Studies Group International Conferences, University of Westminster, 2014, 2017, 2018 (**Draper**). 1st International Social Prescribing Network Research Conference, Salford, 2018 (**Polley**). UK Society of Biomaterials Annual Conference, London, 2016 (**Roy**), 6th European Phycological Congress, London, 2015 (**Lewis**).

Contributions to funding organisations: Austrian Science Fund, 2018 (**Gerbault**), BBRSC, 2014–2019 (**Barr, Dalby, Draper, Dwek, Volpi, Zariwala**), BHF 2014- (**Barr**), Biochemical Society - Eric Reid Fund for Methodology, 2016– (**Dwek**), Brain Research UK, 2019 (**Uysal-Onganer**), Breast Cancer Now, 2016–2018 (**Dwek, Montano**), British Council Newton Fund, 2018 (**Lewis**), DEFRA, 2015 (**Draper**), DFG, Germany, 2015 (**Roy**), Diabetes UK, 2017– (**Zariwala**), EPSRC, 2014– (**Dalby, Dwek, Roy**), ESRC, 2016- (**Draper, Ridge**), EU Policy Evaluation Network, 2017 (**Draper**), FWF, Austria, 2014 (**Roy**), Glasgow Children's Hospital Charity, 2016 (**Draper**), Inserm – Département de l'Evaluation et du Suivi des Programmes - Modèles Expérimentaux, 2018- (**Dwek**), Leverhulme Trust, 2016 (**Dartnell**), MRC, 2014– (**Barr, Elliott, Dwek**), National Science and Research Centre, France, 2018 (**Dwek**), National Institute for Health Research, 2014– (**Ridge**), National Science Center, Poland, 2018 (**Dwek**), Natural Sciences and Engineering Research Council of Canada 2017, 2018 (**Lewis**), NSFC, China, 2014 (**Roy**), Royal Academy of Engineering, 2018 (**Roy**), Royal Tropical Institute, Amsterdam, 2016 (**Draper**), Telethon, Italy, 2015 (**Volpi**), U.K. Space Agency, Aurora grant 2014– (**Dartnell**), U.K. Space Agency, Aurora grant, 2018– (**Dartnell**), University of Sharjah - United Arab Emirates, 2018 (**Dwek**), Wellcome, 2015–2020 (**Bell, Dwek, V. Patel, Volpi**).

Visiting Research Fellows: Honorary Senior Research Assistant, University College London (**Gerbault**), Honorary Senior Research Fellow and Lecturer UCL, Great Ormond Street Institute of Child Health (**Montano**), Honorary Visiting Scientist Imperial College, London (**Montano**), Visiting Fellow in Molecular Cytogenetics, Nuffield Department of Medicine, University of Oxford (**Volpi**).

COLLABORATION AND INTEGRATION WITH PUBLIC BODIES:

NHS AND SOCIAL CARE: National Institute of Clinical & Healthcare Excellence (NICE): 1st U.K. wide guidance on managing and treating depression in adults and featured in the updated edition: National Clinical Practice Guideline 90, published by The British Psychological Society and The Royal College of Psychiatrists (**Ridge**). Additionally, featured in the November 2020 NICE Myalgic encephalomyelitis (or encephalopathy)/chronic fatigue syndrome evidence reviews for the non-pharmacological treatment of CFS/ME. Guy's & St Thomas's NHS Trust: Developed intensive resilience training programmes for mental wellbeing of medical practitioners and workshops for doctors to help them better cope and perform safely and competently under stress (**Ridge**). NHS England Outcomes Framework Development Group: Committee Member (**Polley**), 2017–2018. North West London NHS Clinical Commissioning Group: Design and implementation of £50M Social Prescribing Strategy (**Polley**), Jan–Oct 2019. Kensington & Chelsea Clinical Commissioning Group: Chair, Yoga for Health (**Polley**), July 2017–2019. 55 NHS Hospitals: DietCompLyf Study (**Dwek**), 2012–ongoing.

GOVERNMENT ADVISORY BODIES: Greater London Authority: Member of Evaluation Sub-committee for development of Social Prescribing Strategy for the Mayor of London (**Polley**), April 2018 onwards. Social Prescribing Youth Network: Chair of Expert Advisory Group (**Polley**), Oct 2018–ongoing. Social Science Research Committee. A Scientific Advisory Committee to the UK Food Standards Agency: Expert Member (**Draper**), 2011–2018. National Centre for Social Statistics: (**Draper**), 2015–ongoing. UK BioBank: (**Bell, Dwek, Thomas**), 2014–ongoing. Pirbright Institute: (**Dalby**), 2015–ongoing. The MARCH Network. (**Polley**), 2018–ongoing. Wellcome Trust. Physiology in Health & Disease Expert Review Group (ERG 6): (**Polley**), 2016–2020.

SPECIALIST WORKSHOPS: Institute of Biomedical Sciences (IBMS) London Region Cellular Pathology Discussion Group: convenes 4-5 evenings per year, at least one of which is hosted on the Fitzrovia campus. "*Issues with Tissues*" is a one-day annual conference, covering a range of themed subjects encompassing research, applied biomedical science and workshops. The annual event is hosted at the Marylebone campus and attracts up to 300 delegates with a national and international reach. The annual conference is supported by companies including Agilent, AnatoPath, Biocartis, CellPath, Histocyte Laboratories, and Roche.

COLLABORATIONS WITH INDUSTRIAL PARTNERS: AInostics (UK): development of machine-learning models for the "opportunistic" analysis of standard clinical MR images. AMRA (Sweden): development of new standard for quantitative imaging in diabetes and sarcopenia. Attana AG, (Sweden): Development of methods to allow interaction kinetics between drugs and cancer cell surfaces. Calico (USA): development and implementation of AI based pipeline for the large-scale MR image analysis of UK Biobank. GW Pharma (UK): Confidential – Assessment of functionality of novel products. HerbaLife (USA): Confidential – Assessment of functionality of novel products. Kirkstall (UK): Development of fluid flow into 3D models of solid cancers. Perspectum (UK): Development of quantitative imaging methodology for assessment of liver function in health and disease, including longterm-COVID19 effects. Pukka Ltd (UK): Confidential – Assessment of functionality of novel products. PhytoQuest (UK): Confidential – Assessment of glycosidase inhibitors as anti-cancer drugs. Select Research: Development and implementation of App for individual and large-scale body composition assessment and tracking (e-Health). Sun Tan (Taiwan): Confidential – Assessment of functionality of novel products.

PUBLIC ENGAGEMENT:

The founding ethos of the University was to share knowledge and research in the arts and sciences with the public, and throughout this period the School has undertaken significant public engagement activities linked to our research activities. These are broadly grouped into 4 areas, reflecting different stakeholders and area of impact:

1. **YOUNG PEOPLE**: Obesity Day Event: (**Volpi**) 2016 onwards. School Science Symposium: (**Thomas**) 2016 onwards. Interactive Medical Research Workshops: (**Volpi**) 2017 onwards. Nuffield Foundation Medical Research placements: (**Dwek, Robertson**) 2016 onwards. Problem-Based Learning Workshops: (**Dartnell**) 2019.

2. **PUBLIC ENGAGEMENT:** New Scientist Expo: (**Dwek, Elliott, Smith**) 2017. Cheltenham Science Festival: (**Bell, Dartnell**) 2016/2017/2019. SparkLab Washington DC: (**Lewis**) 2018/2019. Hong Kong 'Science Alive Festival: (**Dartnell**) 2017 (Dartnell). KAUST, Saudi Arabia: (**Dartnell**). 2016. Tate Modern on use of plastics: (**Roy**) 2018. ikJi Festival, Korea: (**Dartnell**), 2016. British Council Mauritius: (**Dartnell**) 2017 lecture tour Hay Festival: (**Dartnell**) 2019. Against Breast Cancer Charity Open Days for Public Awareness (**Dwek, Robertson**) 2018. York Festival of Ideas: (Dartnell) 2019.

3. **PUBLIC POLICY**: Business Women from the City of London Event and for Europa DONNA UK, House of Lords: (**Montano**) 2018. Executive member of Europa DONNA UK at the Royal Society of Medicine: (**Montano**). STEM for Britain: (**Zariwala**) 2017. STEM Ambassadors: (**Dwek, McCormick, Uysal Onganer, Zariwala**) 2016 onwards.

4. **BEYOND THE LECTURE THEATRE**: we have taken our scientific research endeavours and discussion beyond the normal constraints of public engagement. Funzing and Nerd Nite: (**Chong**) 2019. Pub PhD London, PhD students presenting and discussing their work away from lecture theatres 2017 onwards. Street Science (**Thomas**) 2016

MEDIA: Our research has generated a great deal of interest, nationally and internationally, appearing frequently in the printed press as well as visual and social media. It has featured in News items as well as popular science/health programs and articles, including:

- **PRINTED PRESS:** BBC Sky at Night magazine: (**Dartnell**) monthly column. Daily Mail: (**Thomas**) 2015; Economist: (**Polley**) 2018. Evening Standard: (**Dartnell**) 2019. Express: (**Bell, Dartnell, Dwek**) 2015, 2019. Guardian/Observer: (**Ridge**) 2015, (**Dartnell**) 2019). Handelsblatt: (**Thomas, Bell**) 2016. Huffington Post: (**Roy**) 2018. Independent, (**Chong, Ridge**) 2017, (**Dartnell**) 2019. International Business News: (**Chong**) 2017. Metro: (**Chong, Dartnell**) 2017, 2019. New Scientist: (**Dartnell, Dwek**) 2019. New Zealand Herald: (**Chong**) 2017. Saga Magazine: (**Dwek, Polley**) 2018. Sun: (**Chong**) 2017. Telegraph: (**Dwek**) 2015, (**Bell, Ridge**) 2017. Times of Malta: (**Chong**) 2018. Wall Street Journal: (**Chong**) 2015.

- **TELEVISION**: BBC-1: “How to Stay Young” 2016 (**Bell**). BBC2: “Twinstitute” 2019 (**Elliott**). BBC News: 2017, 2018, 2020 (**Elliott, McCormick**) “Coronavirus: How to wash your hands” (**McCormick**). BBC Royal Institution Christmas Lecture: 2016 (**Elliott**). Channel 4: “How to lose weight well” 2017, 2018 (**Elliott, Bell, V. Patel**). ITV: “100 Years Younger” 2017, 2018 (**Elliott**). ITV: “Good Morning Britain”, 2017 (**Elliott**); ITV: 2019 (**Polley**).

- **RADIO:** Radio-1: 2016 (**Elliott**). Radio-4: 2018 (**Polley**). Radio Canada BC: 2018 (**Polley**). BBC-3 Counties Radio: 2017 (**Uysal-Onganer**). BBC Radio 4’s Woman’s Hour: 2015 (**Dwek**).

- **SOCIAL MEDIA:** The Conversation: 2017/2018 (**Chong, Elliott, Mohammed, Uysal-Onganer**). Channel News Asia: 2019 (**Chong**). Daily Mail Online: 2015 (**Dwek**). King’s Fund Webinar: “Social prescribing”, 2018 (**Polley**). LifeScience: 2015 (Chong). Runnersworld: “Hidden fat and how to beat it” 2016 (**Bell**). TEDx Talk: “Oxygen and Life” 2017 (**Elliott**). UKHealthRadio: 2018 (**Polley**). YouTube Series: “Brothers do Science” 2017 (**Elliott**). UK Biobank: “Imaging the body” 2016 (**Bell**).