

Unit-level environment template (REF5b)

Institution: London Metropolitan University
Unit of Assessment: UoA 3 Allied Health
1. Unit context and structure, research and impact strategy

Overview

In this REF period research in Allied Health Professions the four named research groups that evolved in the REF 2014 maintained their activity, with changes in focus to reflect staff turnover. These groups reflect research interests of a staff base in the School of Human Sciences (SHS), with teaching commitments in Biology, Biomedical Sciences, Blood Science, Chemistry, Pharmaceutical Sciences, Nutrition and Health Sciences and Sports Science. In this REF period we have included a fifth research group into the Unit with interests in health research in the social sciences. There are 27 researchers contributing to the Unit spread across the five research groups. This compares with 11 category A staff submitted in this UoA in REF 2014.

Four groups are formed from staff in the School of Human Sciences:

Cellular, Molecular and Immunology Research Centre (CMIRC) (McLean, Meimaridou, Matewele, Inal, Palmer, Jorfi).

Lipidomics and Nutrition Research Centre (LNRC) (Ghebremeskel, Min, Harbig).

Molecular Systems for Health Research Group (MSHRG) (White, Terry, Tandy, Patel, Sykes, Devine, Sil, Shang).

Public Health Nutrition Research Group (PHNRG) (McCarthy, Ghodduzi, McLaren, Walsh).

The fifth group is formed from staff in the School of Social Sciences, the School of Social Professions and the Business School:

Centre for Primary Health and Social Care (CPHSC) (Chandler, Hu, Morriss-Roberts, Webb, Stewart).

The university in its new strategic plan (2019/20-2024/25) places emphasis on investing in staff and post-graduate research students (below) to strengthen the research environment across the university. It includes specific key goals, including engagement with partners to address challenges facing London, for promoting social justice and social inclusion, and to support staff to develop internationally excellent and world-leading research. The challenges of obtaining external funding are evident from this environment statement and a current priority is to maximize efforts to seek funding from the full breadth of opportunities available.

Responding to the enhanced commitment to research at London Met, we have developed a clear research focused agenda for the school (SHS) and have put in place interventions aimed at enhancing the place of research within the school, together with aligning it with the new University strategy. Our Unit has been able to more than double its number of research active staff. We have achieved this by supporting existing staff, and through strategically appointing new staff who are either established researchers or early career researchers.

A common theme of health research brings the diverse disciplines of the Unit groups together. As can be seen from our Groups and Centres (below), we are interested in infection, disease,

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immunology, diet and nutrition, public and population health, and both theoretical and applied research, laboratory-based science and research through social investigation. The range of people and the variety of what they do points to a diversity that provides opportunities for interdisciplinary studies across the groups which have developed. and are further encouraged through through weekly research meetings for staff and research students across the School, regular (at least monthly) research meetings for all staff, and other *ad-hoc* meetings of smaller research groupings. As an example of inter- and multi-disciplinary approaches the Unit can foster, about 20 staff across all disciplines of the Unit came together in the summer of 2020 in an effort contribute to resolving the Covid-19 pandemic. Within the multidisciplinary group, sub-groups focussing on specific projects in immunology, nutrition, infection, chemistry and biology are working together. Several staff have published contributions to Covid-19 research.

Research Symposia organised across SHS held twice a year are half-day events where colleagues and research students present their work. CPHSC holds regular seminars, often with invited speakers and these are open to all. Our plan going forward is to develop further interdisciplinary research across the Unit and beyond, and to integrate colleagues in applied psychology and social research more fully into the work of a Unit which is so strongly established in the School of Health Sciences.

The future plans of individual groups or centres are aligned with the university's strategic goals as we well as continued expansion of our role in university-level initiatives.

Cellular Molecular and Immunology Research Centre

This group has established a reputation in the field of extracellular vesicles (EVs) and their role in infectious disease (microbial EVs) (Inal, Jorfi, Matewele) and cancer development (the tumour microenvironment and metastasis) (Inal, Jorfi) as well as the use of EVs as targeted therapeutic agents and macrophages and EV involvement in oxidative stress and endocrine disorders (Meimaridou). Another major theme is to monitor immune responses against common viruses such as rhinovirus and cytomegalovirus, and to develop vaccines against these viruses (McLean). Other interests include understanding the role of ion channels in cancer metastasis (Palmer).

These themes will continue to be developed as part of the future strategy and integrated into other research areas of the Unit. For example Meimaridou has started projects with White and Patel of MSHRG exploiting the unique model of oxidative stress she has developed. Moreover, a review of the Centre's work has revealed areas with particular potential for impact, for example McLean's work on vaccines, that will provide a focus for future development.

During this census period, the centre has published more than 40 original papers, 21 international conference abstracts, 2 book chapters, supervised 6 PhDs to successful completion and there are currently 9 PhD students.

Lipidomics and Nutrition Research Centre

LNRC has been active as an independent group since 2010 and has developed an international reputation through its distinct expertise on characterizing the role and therapeutic use of essential fatty acids (EFA) in chronic diseases. The centre has the relatively rare laboratory capability of lipidomic analysis, allowing detailed analysis of, for example, patient lipids from clinical trials. The main aims of LNRC are to investigate: 1) the therapeutic potential of omega 3 and 6 fatty acids and vitamin D for chronic disease and elucidate mechanisms of action; 2) how receptor function and signalling, cognitive function and behaviour are affected by changes in membrane lipid composition;

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3) the use of magnetic resonance imaging of brain pathology in patients with chronic diseases; 4) placental fatty acid receptor and transporter protein function and dysfunction in pregnancy and foetal development; 5) the effect of saturated and unsaturated fatty acids on the insulin action of hypothalamic neurons; 6) the role of fatty acids and related lipid mediators in immune function, and autoimmune and inflammatory disorders. Members have organized three clinical trials, described below. The centre has collaborations with nine countries outside the UK, seven hospitals and universities in the UK. The centre's work has been co-ordinated by Ghebremeskel and Min. Harbige joined in 2016, bringing in expertise on the role of EFAs and related lipids in immune function.

Future efforts will continue to produce research that is translational and has impact on health practice locally, nationally and potentially globally, by maintaining and developing national and international collaborations with both academic and industrial researchers and researchers in the health professions.

Specific objectives include, to:

- Elucidate the inter-relationships between nutrition, specifically saturated and essential fatty acids, and inflammation in newly diagnosed type 2 diabetic patients in Egypt, Mexico and Nigeria.
- Investigate changes in testosterone, sex hormone-binding globulin, dehydroepiandrosterone levels and cervical length during pregnancy in women, with and without polycystic ovary syndrome, with a history of recurrent miscarriages.
- Assess body mass index, blood pressure, blood sugar level and educational performance in children born to mothers with and without diabetes mellitus who participated in our pregnancy study at Newham General University Hospital.
- Perform a brain magnetic resonance imaging study of Sudanese and Nigerian sickle cell patients supplemented or not with omega 3 fatty acids.

During this REF the centre has published 23 peer-reviewed papers, 33 international conference publications, 2 book chapters, has had 5 PhD completions, currently has 5 PG students and co-organised three international conferences (below).

Molecular Systems for Health Research Group

This diverse group includes chemists (Devine, Patel, Sykes, Tandy), a pharmaceutical scientist (Sil) and two biochemists (Terry, White) and an ion-channel physiologist (Shang). Research themes include: 1) metals in biomedicine – development of novel fluorescent metal complexes with useful biomedical applications, (Sykes, Patel, and White) and channelopathies (Shang); 2) synthesis and testing of new compounds with biomedical applications, including treatment of malaria (Devine), and treatment of neurological diseases (Patel, Sykes, Sil, Terry, White); 3) drug delivery systems - topical delivery of drugs through skin and nails (Sil), development of nanoformulations for delivery of poorly soluble drugs or biologicals, based on electrospinning and solid-lipid nanoparticles (White) and nanotoxicology (Shang); 4) protein aggregation in disease, and its treatment (Terry, Patel); 5) there is also a tangential theme of astrochemistry (Devine, Tandy) reflecting specific and well established interests of the staff concerned.

These themes will form the basis of future research, with a view to developing further collaborations across the Unit to enhance the depth and impact of the research. For example Sykes and White also have started joint projects with Meimaridou of CMIRC, and there is a group with interests in phytochemistry including Shang, Devine and White from MSHRG and Palmer from CMIRC.

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During the REF period so far the group has published more than 50 publications in international journals, 29 presentations at international conferences, has had 6 PhD completions and currently has 6 post-graduate research students.

Public Health Nutrition Research Group (PHNRG) (Ghoddusi, McCarthy and McLaren). The group lead (McCarthy) has been part of this institution's submission to Subjects Allied to Medicine since 1996, sustaining its core presence in health-related research for the last 24 years since. Obesity assessment, management and metabolic disease risk remain core research themes. This has extended into international collaborations evaluating meal replacement strategies to improve body weight, composition and metabolic disease as well as commencing a new theme on obesity and metabolic risk in UK firefighters. One key objective is to help address health inequalities as part of the university mission on social justice. Research during this census period has further characterised skeletal muscle and adipose tissue masses in children of South Asian and African-Caribbean heritage, leading to better clinical and surveillance tools in these population groups. This work has driven forward research into infant undernutrition in rural Bangladeshi infants and with McLaren joining the group, a novel obesity assessment tool has been developed for resource-poor populations in South Africa. An impact case study has resulted from the research conducted by the group.

PHNRG will conduct investigations which would enable us to:

- Better evaluate the impact of infant and childhood growth across different populations on the partitioning of energy and nitrogen into skeletal muscle and adipose masses and how this impacts risk for metabolic disease and sarcopenia/sarcopenic obesity.
- Produce assessment tools for field and clinical use to identify children of South Asian and African-Caribbean heritages who are at risk of overweight/obesity and metabolic disease.
- Evaluate the impact of diet and lifestyle interventions on body composition and blood measures of metabolic disease in clinically obese individuals as well as across the UK firefighter service.
- Develop tools to quantify dietary risk (eg sodium intake) in clinical populations, particularly those with type 2 diabetes.

Within PHNRG is the Microbiology Research Unit which focusses on understanding and characterising traditional and contemporary fermented foods, their microbiota, and their potential beneficial effects as probiotics as well as measuring risks such as antibiotic resistance gene transfer. The unit will continue these themes and attempt to broaden the impact by including a study of the characterization of breast milk microbiota and their potential probiotic characteristics. In alignment with the University's research strategy of promoting social justice the research remit will include understanding foodborne pathogens and control measures.

During the REF period so far the group has published 17 publications in international journals, 13 presentations at international conferences, has had 6 PhD completions and currently has 6 post-graduate research students.

Centre for Primary Health and Social Care

With origins dating back to 2005 this group includes staff from the School of Social Professions (SPR) the School of Social Sciences (SSC). Research in population health and applied health is

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carried out to underpin policy development, education, and practical applications for enhancing health and well-being. The current focus of the research strategy is long-term conditions and non-communicable diseases including: 1) English Longitudinal Study of Ageing (ELSA) studies on wellbeing in later life; 2) physical activity in cancer survivorship; 3) obesity and food environment; 4) alcohol consumption among patients with long-term conditions, and 5) psychological approaches to alcohol dependence.

Looking to the future collaborations will be developed with a recent partnership started with a local hospital, the Whittington Hospital NHS Trust (London Borough of Islington). This partnership will strengthen our ability to develop innovative projects focusing on improving health and healthcare for local people. We will further develop our capacity in applied health research by a strategic new staff appointment, Prof Duncan Stewart, who has joined us from the University of York and has an outstanding track record in applied health research. SPR has also co-provided HEIF funding (£44,000) for a new collaborative project with Whittington Hospital, the Business School and SPR to investigate on a cluster of applied health research projects.

Members of the group have published 49 peer-reviewed articles, 2 book chapters, and 2 textbooks, achieved 7 PhD completions (Psychology) and are currently supervising 2 PhD students in health (SPR), and 5 PhD students in Psychology (SSC).

During the period of this REF staff across the Unit have published about 175 peer-reviewed research articles, reviews and book chapters. Most of these reflect the research aims of individual groups, but interdisciplinary collaboration is encouraged through Unit-wide research events, seminars and presentations and one member of the unit, Professor Gary McLean, is co-coordinating a university wide Interdisciplinary Research Forum together with Professor Svetlana Stephenson from the School of Social Sciences. The forum's remit is to promote opportunities for collaboration across disciplines and has invited academics and PhD students from across the university, to facilitate interdisciplinary interactions. Colleagues in the Unit have also played a key part in the PVC Research's new Research Showcase sessions (Inal, McLean, Shang).

Some examples of cross-discipline collaboration include work by White (UoA3) with Professor Hassan Kazemian (UoA 11) of the School of Computing and Digital Media in bioinformatics which has resulted in PhD co-supervisions and publications. Genetics Fairbrother (UoA3) and history MacRaild (UoA 25) are being combined in a new approach to understanding the health and migration patterns of the Irish diaspora.

2. People

[Staffing

During this REF period LMU has undergone two reviews of its institutional strategy, with the most recent, 2018-19, leading to significant changes in the university's approach and support for research, with an ambition to grow the research undertaken by the university and enhance the impact it has. The three strands of the strategy include improving infrastructure to support research, to increase the quality of research and the number of research active staff, and to improve the impact the research has at a local, national and international level.

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In the natural course of staff turnover new staff with clear research expertise are appointed. In this REF period there have been 14 new appointments across the Unit (Patel, Tandy and Sil in Chemistry / Pharmaceutical Sciences; Harbige, Meimaridou, Terry, Jorfi, Inal and Shang in Biological Sciences; Walsh and McLaren in Health Sciences; Hu, Hunter, Stewart in Social Sciences). Inal, Shang and Stewart were appointed in response to a national advertisement for Vice-Chancellor Research appointments across the university at all career levels. Inal was a former LMU professor who left in 2017 to take up a position as Associate Dean of Research. Following the change in research strategy by the university he was reappointed by LMU. The research interests of Shang and Stewart complement existing interests and provide opportunities for new collaborations.

Staff Development

All research active staff in UoA3 are encouraged to join one of the five research centres or groups and are pro-actively supported by the group leader to develop research. This happens through i) allocation of laboratory space, and/or other facilities or resources for research; ii) encouragement, and prioritization for new researchers, of bids for allocation of local funds (especially from the university's REF and HEIF funding); iii) mentoring, especially for early career researchers; iv) organization of training for PGR supervision. Research groups hold regular meetings to update members on progress, discuss new ideas and foster collaboration.

Staff identified with external funding, those with track records of publication, and those with potential have been supported with workload hours to pursue their research. Partial and full workloads for research amount to 30 hours and 100 hours reduced from Formal Scheduled Teaching (FST). Staff who wish to develop their research activity are offered designated mentoring support to develop their profiles; all staff who wish to avail of mentoring are able to do so. Staff also can participate in university-wide researcher development training, and a number of our staff have done this, attending sessions on mentoring relationships, research impact, and research funding,

In 2019, the university re-instated opportunities for promotion through research output and in the most recent round four members of the Unit were promoted: McLean to Professor of Molecular Immunology, White to Professor of Molecular Biosciences, Meimaridou to Reader in Molecular Mechanisms of Disease, Terry to Reader in Protein Pathology.

The mentoring programme and development activities for encouraging research active staff, or staff to be research active, and other initiatives are part of a programme for research training led by Professor Digby Warren, head of the Centre for Professional Education and Development. Workshops have included career progression, PG supervision, PhD examining, chairing PhD exams, applying for grants, publishing research, research methodology and mentoring colleagues. The workshops are led by senior staff and include presentations from outside the university, for example from major grant-awarding bodies such as the Wellcome Trust and EU Horizon 2020. The university has a Research and Postgraduate Office which provides support for staff, including seeking funding sources, writing and submitting grant applications, providing links to local organisations to encourage collaborations.

Two research away-days are held each year across SHS, in which staff can present their work. There is a weekly School letter that publishes highlights of research achievements from staff and students, including publication of papers, meeting presentations, media appearances, awards,

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PhD vivas etc. There is also provision for mentoring within staff across the School, to allow more experienced researchers to encourage the research of early career staff.

CPHSC hosts an annual Interdisciplinary Health and Wellbeing Research Conference as an opportunity to showcase research being undertaken. The conference explores interdisciplinarity in relation to health and wellbeing, and it brings together lecturers and students from various disciplines including Social Work, Youth Work, Public Administration, Community Development, Education and Health. In so doing, this conference seeks to stimulate discussion on how methodological diversity can be applied to complex questions relating to health and wellbeing. As well as staff presentations, opportunities are given for undergraduate, postgraduate, and PhD students, to present their work.

SHS has an experienced researcher Prof Gary McLean to co-ordinate and develop research impact strategies and activities.

Post-graduate Students

There have been 49 PhD completions over the period 2013-2020 and there are currently 32 PG research students active across the Unit.

Recruitment of PGR students in the SHS is co-ordinated through the university Research Office by a named experienced member of staff (McLean). PGR students are registered at October and February entry points, when they are required to attend an induction programme. All students are required to have two members of staff on the supervisory team. Students share dedicated, spacious open-plan offices with an allocated desk.

A continuing requirement for progression through the PhD programme is attendance of a range of workshops and seminars, hosted by the Post-graduate Research Office. These support development of generic skills for research including formulating the research problem, literature and database interrogation, oral presentation, writing skills, preparation for the oral exam, statistics. There is a PGR student portal on the university VLE, WebLearn, in which all students are registered automatically, and which provides a useful means of communication, as well as a repository of links and learning materials to support their training. The portal also allows online submission of progress and transfer (MPhil to PhD) reports, including a facility for checking writing for similarity (plagiarism).

SHS has a member of staff (Meimaridou) who has the named role of PhD Co-ordinator for the School of Human Sciences. As well as acting as a contact for all PGR students, Meimaridou helps to co-ordinate the PGR training for the university, PGR events for SHS and monitors general PGR issues, through the regular PGR research update meetings held every week (described below). Social professions PBR students in health studies are also supported by a PhD Co-ordinator.

The three Schools contributing to this unit all hold regular post-graduate seminars. School of Human Sciences students are required to attend research seminars every week in which they present an update of their research. Occasionally staff will lead sessions on aspects of research training more focussed on the sciences compared with offerings elsewhere in the university. In practice students have the chance to present their work at least twice a year in this informal forum, which is attended by students and staff. The presentations are relatively concise, and importantly there is plenty of time for questions and discussion, which provides valuable feedback and training for the student. The meetings also provide a forum to discuss housekeeping issues including Health and Safety, risk

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assessment, ethics, issues with equipment, resources and training. The meetings are open to all staff in the School, both academic or technical support, and are attended by the Manager of the Science Centre where all the research labs are located. Often issues with resources or Health and Safety can be addressed directly by the Science Centre Manager.

A PG representative, nominated by the PG student body, is invited present PG concerns to School Research, Knowledge and Enterprise meetings. More immediate concerns can be addressed to the School Research Lead or the PG Co-ordinator.

PG students are encouraged to gain experience in teaching and supervision, where appropriate opportunities are available, and several have taken advantage.

PGR students submit a yearly written report which is reviewed by an academic who is not part of the supervisory team, and who provides feedback. Supervisors also provide feedback and a recommendation to allow progression. PGR students have a further opportunity to raise concerns in the report. Each School has a PGR student Progression Committee that meets twice year to consider the progress of each student, where concerns can be raised and extra support for students be arranged as necessary.

Support for PGR students extends, where appropriate, to attend national and international conferences and symposia to present their work. Students have been supported to attend such key events in the US, Japan, South America and across Europe.

PGR students are encouraged to submit their work to peer-reviewed international journals for publication prior to submission of the PhD. For example Kaleta (supervised by Palmer) Touabi and Siddiqui (McLean), Christofoli (Sil) all co-authored reviews or papers based on their research.

Where there is capacity, PGR students are encouraged to carry out paid teaching to support UG or PG programmes; they also have the opportunity to shadow staff for selected teaching activities, to gain experience in teaching.

Equality and Diversity

The university is committed to equality, diversity and inclusion (EDI) in all its activities, the responsibility of the ProVice-Chancellor for Outcomes and Inclusion. EDI is embedded in staff appointments and PhD student selection and is promoted amongst staff across the School by being required to undergo profession development, for example in understanding unconscious bias. Currently 34% of our academic staff and 65% of our PGR students are BAME. Within the Unit 25% of staff and 40% [this is an estimate] of students are BAME. 6% of the Unit are female compared with 47% of university staff. Many of the projects mentioned below involve population groups from under-privileged parts of the world and align well with the university's mission of social justice.

3. Income, infrastructure and facilities**/Income**

£889k has been received over the period 2013-20 through approximately 30 small awards from UK based charities, industry, commerce and public corporations.

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McCarthy received funding from Almased GmbH of 185k euros for the AMDIT study (Almased Multi-center Diabetes Intervention Trial) and 150k euros for the ACOORH study (Almased Concept on Overweight and Obesity and Related Health Risk)

An ESRC grant of £61,942 was awarded to Bagwell then at CPHSC for the period Oct 13 - Dec 14.

Professor Duncan Stewart is a co-investigator on a National Institute for Health Research funded five-year research programme to co-produce with the pharmacy profession and with patients an intervention that helps incorporate discussion of alcohol within pharmacist-led medication consultations. The programme is led by the University of York, with collaborators from the Universities of Stirling, Reading and Leeds Beckett, University College London and NHS North East England Commissioning Support. Initially studying medicine review services in community pharmacy, the research will now be conducted in primary care following the recent NHS decision to move medicine reviews by pharmacists into this setting. The programme aims to further develop and evaluate the intervention, having studied pharmacist role developments and the delivery of the new medicine review service within Primary Care Networks (PCNs), and to provide evidence to the NHS to inform decision-making at local, regional and national levels on implementation of PCNs and pharmacy services in primary care.

The university's commitment to research has included support for submitting funding proposals. Several Unit staff have been helped to submit proposals, for example to the Leverhulme Trust (Sil), Horizon 2020 (Meimaridou) and to industry for collaborative support (Palmer, McLean).

Infrastructure

The University built a dedicated Science Centre which was opened in 2006 and houses all the laboratory facilities for science in the university.

On the ground floor, in addition to a large sports hall and a separate sports training facility, there is the food preparation laboratory, the Nutrition Research Lab and a clinic area with consultation rooms. These are shared with the public and facilitate impactful research dissemination.

The first floor houses facilities for sports physiology/therapy research and teaching. Also located here is the simulated hospital ward and clinical chemistry facility. The second floor houses the main research lab for PGR students, and other analytical facilities, described in more detail below. The third floor of the building houses the largest science teaching laboratory in Europe (280 bench spaces) for undergraduate and post-graduate degree students. Critically it also provides flexible space and additional laboratory facilities for research, and some of the shared facilities (HPLC lab, analytical lab, formulation lab) are housed in dedicated rooms adjacent to the teaching lab.

Facilities

The Research Lab and associated facilities

Three research groups (CMIRC, LNRC & MSHRG) are housed in a well-equipped large open plan laboratory dedicated for research only, located on the second floor of the Science Centre. This open plan laboratory with shared facilities provides a very conducive environment for stimulating scientific interactions, collaborations, informal training of laboratory skills and mutual support amongst research students. The laboratory has facilities for lipidomic analysis, genome analysis, metabolomics, cellular and molecular biology, immunology, molecular membrane signalling research and for organic synthesis, pharmaceutical formulation development and phytochemical extraction. The laboratory has access to five adjacent rooms that are purpose built for mammalian cell culture,

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microbiology (used by the Food Microbiology Unit of PHNRG), growth of fungi (positive air pressure), a biosafety level II room for dedicated microbiological work, and a lab for patch-clamp ion channel analysis.

There is a suite of networked PCs at the end of the lab for PGR students to work from during their lab work.

Whilst individuals' groups will have their own sets of small apparatus for dedicated purposes, the majority of the major pieces of equipment are shared amongst all researchers. This arrangement was embedded in the open-plan, inclusive philosophy with which the Science Centre was designed. Accordingly the University and School have invested in facilities, equipment and services to promote/facilitate research that is accessible to all.

The clinical trials of LNRC, and analysis of lipid nano-formulations and other fatty molecules, are made possible through the lipidomics facility which houses analytical equipment for separation and identification of lipids, including gas-chromatography / mass spectrometry.

The work of CMIRC and MSHRG benefits from a bespoke mammalian cell culture facility designed as part of the research lab, and includes incubators, safety cabinets, microscopes, and a cryostorage facility. Analysis of cells, cell proteins and metabolites, and extracellular particles (vesicles) is carried out with a Guava® easyCyte™ 8HT laser cytometer, a fluorescence microscope, and a fluorescence / absorbance plate reader.

Cellular work is often combined with genome analysis, made possible with equipment provided by the University and School including real-time qPCR and ordinary PCR machines with associated equipment for DNA analysis such as Nanodrop, electrophoresis apparatus and a gel imager. Recently the School invested in a Nanopore DNA sequencer especially to address the problem of sequencing long repeat sequences as found in telomeres.

In addition there are key items of specialist equipment for preparation and analysis of nano-formulations and cellular nanoparticles, including an electrospinning facility, a Quartz Crystal Microbalance for measurement of nanoparticle release or binding to cells in real time, and a qNano apparatus for measurements on nanoparticles.

Facilities outside the research lab include a total of three mass spectrometers, a 500 MHz NMR spectrometer, an elemental analyser, several HPLC systems, uv-vis, fluorescence and FTIR spectrometers and a Microwave Coupled Plasma-Optical Emission Spectrometer provide a suite of equipment for chemical analysis, run and maintained by the SHS, and shared with undergraduate and postgraduate teaching. Sil and Patel have been given funding to establish a 3D printing facility to make bespoke tools, apparatus and for applications in medicinal chemistry. For pharmaceutical analysis there is also dissolution apparatus viscosity, conductivity, friability (tablet hardness), tablet hardness, tablet press machine.

Science Centre facilities for research in nutrition and health undertaken by the PHNRG include a dedicated nutrition research lab which houses state of the art body composition assessment equipment, including a BodPod (air-displacement plethysmograph) and both single-and multi-frequency bioelectrical impedance analysis (BIA) systems which can differentiate between skeletal muscle, body fat and bone tissue. Some of these BIA systems, together with the sitting height table are being used in field studies, where much of the research is undertaken. There are also open-

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circuit indirect calorimeters for quantifying resting energy expenditure and energy requirements in individuals. Also used is hand-grip dynamometry for assessing muscular strength, and automatic oscillometric monitors for blood pressure measurement. From the sports physiology facility, the COSMED Quark PFT for spirometric (lung function) assessment is used. Food analysis equipment including as bomb calorimetry and the Soxhlet nitrogen analyser are to measure the energy and nutrient content of food.

4. Collaboration and contribution to the research base, economy and society
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Research collaboration with other Institutions

While the research infrastructure in the Unit is robust, and well supported by the Schools and university, it is of necessity limited and many staff benefit from collaborations with labs and institutions that can provide complementary expertise and facilities or provide invaluable clinical links that enable the translational research the Unit undertakes, and to considerably enhance the impact of the Unit's research, described below. London in particular hosts a wealth of biomedical research, and other, institutions and many staff take advantage of the close proximity of London labs to enhance their research through collaboration.

Across the Unit all staff have collaborative links, involving 15 universities, three hospitals and one government laboratory and two companies. Seven staff collaborate with colleagues in UCL and three with IC. Sil is a Visiting Research Associate at UCL, Palmer is a Visiting Researcher at IC, McLean is Honorary Senior Research Fellow at NHLI, IC, Inal is Visiting Professor at the University of Hertfordshire and Meimaridou is Honorary Lecturer at the Centre for Endocrinology, Queen Mary University of London. All the collaborations mentioned have resulted in joint publications and / or joint PhD supervisions.

International collaborations have also provided opportunities for enhancing the scope of the Unit's research to address more global health problems, in particular to host many of the clinical trials and translational work the Unit has been involved with. Across the Unit nine staff have collaborations across Europe (4), Asia (6), the US (1), Africa (7) and South America (3). Ghebremeskel has co-organised clinical trials in Oman and Sudan. The trial in Oman forms the basis of an Impact Case Study in the Unit's REF submission. Harbige has co-organised a trial in Mexico and McCarthy a trial on the use of the food substitute Almased to treat type 2 diabetes, across Europe. More recently White and Harbige have started a collaboration with White's ex-PhD student, based at Biruni University, Istanbul, Turkey, to assess the effect of nutrients on the immune status of Covid-19 patients.

Staff also facilitate collaborations through membership of international research networks. Devine is a member of the network of Researchers in Horizontal Gene Transfer and the Last Universal Common Ancestor (NoR HGT-LUCA) and is chemistry co-ordinator of the Atacama Desert Project. Meimaridou is part of the Marie Skłodowska-Curie Actions (MSCA) - Innovative Training Networks (ITN) European Training Network on Extracellular Vesicles in healing (EViL), with co-participants from the Netherlands, France, Germany, Italy and Portugal. Palmer was a member of the EU funded systems biology of cation transport in yeast collaboration TRANSLUCENT-2.

Sil is co-leader of the Academy of Pharmaceutical Science focus group: Skin Forum.

Webb is a member of the Cancer Expert Group, Faculty for Sport and Exercise Medicine; Public health England Moving Medicine project; Expert Advisory Group Arthritis Research.

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Several workshops and international meetings have been organized by UoA3 staff.

1. Harbige was Organiser and Chair of the 11th International Conference on Immunonutrition, hosted at LMU Sept 2018 (<http://www.immunonutrition-isin.org/>). Ghebremeskel was a co-organiser and Ghebremeskel, McCarthy and White chaired sessions.
2. Chandler was co-organiser of a conference hosted at LMU in November 2018 *Street Drugs in the Big Smoke*, which explored current drug policies in the UK in comparison with other countries. Speakers from Portugal and Uruguay provided an international perspective. The audience included students, academics and policy-makers.
3. Chandler was on the Program Committee of the 2019 TEAP (Tagung Experimentell Arbeitender Psychologen) annual meeting hosted at London Metropolitan University.
4. Sil has co-organised the annual Skin Forum (focus group of the Academy of Pharmaceutical Sciences of Great Britain) meeting since 2016 and is currently the Treasurer.
5. Palmer co-organized an international symposium on sigma-1 receptors for the British Pharmacological Society in December 2016.
6. Webb organized a workshop for the British Lung Foundation to promote life-style interventions for chronic sufferers of lung disease.
7. Ghebremeskel co-organised an International Conference on Seafood Safety, Quality and Traceability Systems. Muscat, Sultanate of Oman, 03-05 March 2014.

Contributions to and impact on wider society

Work from the Unit has been highlighted in the press, staff have contributed to press commentaries and articles, and in some cases, there has been a broader impact.

1. Matewele's work on risks to human health by microbes found in public life has attracted a lot of media attention. The work focusses on identifying potentially life-threatening bacteria, which may have acquired antibiotic resistance, in swabs taken from public places. He has characterized the presence of bacteria around the home: (<https://www.mirror.co.uk/news/uk-news/nasty-germs-lurking-your-home-9724278>); on money: (<https://www.moneywise.co.uk/news/2018-10-02%E2%80%8C%E2%80%8C/coins-bank-notes-are-crawling-bugs-deadly-diseases-researchers-find>); on reused water bottles (BBC 1 Food: Truth or Scare broadcast 14th Feb 2017), on touch-screens in fast food outlets, reported in the *Metro* (<https://metro.co.uk/2018/11/28/poo-found-on-every-mcdonalds-touchscreen-tested-8178486/>), and in fizzy drinks sold in cinemas, reported by the BBC: (<https://www.bbc.co.uk/news/health-44060290>). His analysis of microbes on the London Underground was featured by the BBC (<https://www.youtube.com/watch?v=INiPvVtL30>), and the *Metro* and the *Evening Standard*: (<https://www.standard.co.uk/news/transport/revealed-nine-of-the-world-s-deadliest-superbugs-found-on-tube-with-victoria-line-the-dirtiest-a3540051.html>). As a result, Transport for London ordered the deep cleaning of 50 stations on the London Underground, reported in the *Guardian* (<https://www.theguardian.com/uk-news/2017/jun/23/london-underground-steps-up-cleaning-regime-tackle-superbugs-bacteria>) There was also a petition to parliament (No.211753 *Offer free hand sanitisers on the TFL underground train stations*. Tragically Dr Paul Matewele was a victim of the SARS-CoV-2 pandemic and passed away on 7th April 2020. His achievements were acknowledged by the BBC (<https://www.bbc.co.uk/news/uk-england-london-52208057>) and the *Metro* (<https://metro.co.uk/2020/04/08/leading-microbiologist-dies-contracting-coronavirus-12525532/>).
2. McCarthy has continued his ground-breaking work on the measurement of obesity in children, highlighted as a case study in the previous REF submission. His earlier work established the importance of waist to height ratio, rather than BMI, as an index of obesity. McCarthy

Unit-level environment template (REF5b)

- developed body fat reference curves for children which have been widely adopted – the original publications of 2001 and 2006 have each been cited over 400 times; the reference curves are used by the two largest providers of weight management services, MoreLife and Everyone Health, NICE (National Institute for Clinical Excellence <https://www.nice.org/guidance/CG155/uptake>) in guidelines for management of psychosis and schizophrenia in children and for general monitoring of health in children and the International Diabetes Federation for defining metabolic syndrome in children and adolescents (<https://idf.org/our-activities/advocacy-awareness/resources-and-tools/61:idf-consensus-definition-of-metabolic-syndrome-in-children-and-adolescents.html>).
3. Webb, in collaboration MacMillan Cancer Support and the University of Surrey, has developed an intervention package, the Move More Pack, to improve the quality of life of cancer sufferers which encourages increased physical activity through remote print-based intervention supported by internet tools, based on his published research (Webb *et al.* 2019). Public Health England, the British Lung Foundation and Versus Arthritis amongst others have shown interest in the package. This work is described in an impact case study.
 4. Work by nutrition PhD student, Greg Lessons (co-supervised by McCarthy), a former fireman with the London Fire Brigade (LFB), has led to the adoption of a nutritional Well-Being programme by the London Fire Brigade, reported by the BBC (<https://www.bbc.co.uk/news/av/uk-england-london-50976939/london-fire-brigade-nutritionist-helps-firefighters-keep-fit>). His research has been acknowledged by his award as Nutritionist of the Year 2019 from the Caroline Walker Trust (<https://www.london-fire.gov.uk/news/2019-news/november/first-ever-fire-brigade-nutritionist-scoops-top-award/>) and he currently publishes cooking advice on the LFB web-site (<https://www.london-fire.gov.uk/news/2020-news/april/lockdown-cooking-with-greg/>). Greg was short-listed for two awards in the Public Sector Catering Awards 2020 and won the award for Health and Nutrition <http://pscawards.co.uk/winners-2020>.
 5. Stewart established that primary care patients with one or more long term conditions are at increased risk of death if they consume more than 24 units of alcohol per week. Whilst increased mortality risk associated with alcohol consumption is similar for men and women, smoking and deprivation modify the measured effects of alcohol, increasing the risk of mortality.
 6. Chandler also demonstrated that individuals with alcohol dependence are impaired in their ability to spontaneously process social information in real time. This deficit in automatic social processing is relevant to alcohol treatment settings, which often rely on the construction of a therapeutic relationship.
 7. McLean has been interviewed several times about his work on viral vaccines on Radio and has had his work featured in The Guardian, Washington Examiner and Bild am Sonntag. He has also appeared more than 50 times on television and radio to comment on the SARS-CoV-2 pandemic.
 8. Terry has been involved in outreach work to promote science, especially neuroscience, to school children, with funding won from the MRC and Biochemical Society. She has designed and delivered workshops to schools in London and through the Biochemical Society's Bright Sparks events. She has published articles about her work in the MRC Network Magazine, Roots and the Biochemist. She recently gave an interview about her area of research on the Talking Biotech podcast (<http://www.talkingbiotechpodcast.com/252-prions-infectious-proteins/>).

Contribution to the discipline – translational research

Several studies have been undertaken within the Unit that illustrate the Unit's commitment to addressing societal problems in health.

1. Min, in collaboration with Newham General University Hospital, London has conducted an intervention study with omega 3 fatty acids in pregnant women with type 2 and gestational diabetes mellitus (registration no. ISRCTN68997518). This investigation, which the first of its kind, demonstrated supplementation is effective in alleviating omega 3 fatty acid insufficiency in mothers and babies in type 2 diabetic women (Diabet Med. 2014;31(11):1331-40) and only in mothers in gestational diabetes (Clin Nutr. 2016; 35(3):608-14).

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2. Ghebremeskel, in collaboration with the Faculty of Medicine, University of Khartoum & Department of Public Health, Qatar University, co-ordinated a trial to assess supplementation with omega-3 fatty acids, eicosapentaenoic or docosahexaenoic on seizure frequency in epileptics (ISRCTN57643242). The supplements were found to reduce seizure frequency by about 40% in patients with drug-resistant epilepsy (Epilepsy Behav 2018; 87:32-38).
3. McCarthy has been a partner in two international clinical trials of Almased, a soy-based dietary aid for helping to manage overweight and obesity and related metabolic disease that has been marketed in Germany for 25 years. Both are funded commercially by Almased GmbH. The AMDIT study (Almased Multi-center Diabetes Intervention Trial, NCT01702012) received funding of 185k euros to LondonMet. Partners included teams from Brazil, USA, Germany and India. This study was conducted between July 2012 and October 2014. The ACOORH study (Almased Concept on Overweight and Obesity and Related Health Risk, registered in the German Clinical Trials Register DRKS00006811) received funding of 150k euros to LondonMet and involved 10 partner institutions across Germany, Austria and France. In the UK, McCarthy collaborated with BartsHealth NHS Trust/Queen Mary University London to host the clinical parts of the studies. This study was conducted between June 2016 and July 2018.
4. Walsh participated in the Transfusion and Treatment of severe Anaemia in African Children randomised controlled trial (TRACT trial; International Standard Randomised Controlled Trial registry, ISRCTN84086586) which studied the effect of antibiotic treatment on survival of children suffering from iron deficiency anemia after discharge from hospital after treatment, described in Walsh's output.
5. Harbige co-designed and implemented a series of randomized, single-blinded, placebo-controlled pilot studies on the effect of supplementation with omega-3 fatty acid on metabolic and inflammatory biomarkers in type-2 diabetics in eight Urban Public Health Centres in Toluca, Mexico (funded by the Consejo Nacional de Ciencia y Tecnología (CONACyT), Scientific Development Proposals for the Attention of National Problems No. 212946. México). The findings were published in *Nutrients* (2017).

*Contribution to and recognition by the research base**Journal reviewing and editing*

The expertise of most staff in the Unit is called upon for reviewing submission to academic journals and in some cases being on the editorial board. 17 staff have reviewed articles across about 60 international journals, and four books. Contributions to editing for journals include: Harbige as Senior Editor for Journal of Inflammation since 2016, and was Guest Editor for Annals of Nutrition and Metabolism in 2018; McLean is an Editorial Board Member of the American Journal of Biomedical Research, was editorial board member for Annals of Vaccines and Immunization 2014-2015 and a guest editor for the special issues of Antibodies "Antibodies Therapies against Infectious Diseases" 2014 and also for Frontiers in Microbiology "vaccines against antigenically variable viruses"; Patel is on the editorial board of Material Highlights and Journal of Chemistry; Sil is on the Editorial Board of the International Journal for Cosmetic Science.

External Talks

Staff have attended national and international conferences as invited speakers including nine as keynote or plenary talks, and 25 invited conference presentations, across 13 countries. Examples of keynote presentations include Chandler at the Norway 2016 Conference on stimulants and MDMA,

Harbige at the 10th ISIN Anniversary Symposium in Madrid 2017 and the 7th International Immunonutrition Workshop, Bari, Italy 2014, McLean at the British Association for Lung Research, Sheffield UK 2016 and was also an invited speaker for the science and technology forum of The Reform Club, 2018, and White presented an invited lecture at the National Conference on Recent

Unit-level environment template (REF5b)

Advances in Pharmacovigilance in Drug Discovery and Development, at AKS University, Satna, India 2019.

Fellowships

Ghebremeskel, Inal, Terry and White are Fellows of the Royal Society of Biology. Shang is a Fellow of the Physiological Society.

Grant reviewing

Ghebremeskel has reviewed grant applications for the BBSRC, MRC and Action Research.

McLean has reviewed grants for The Humane Trust and the Marie Curie WHRI Fellowship Program 2014-2017.

White has reviewed grant applications for the BBSRC, MRC and the Rosetree Trust.

Prizes and awards

Several publications have been highlighted in their fields:

Patel's paper 2019 was nominated for a journal award.

Syke's paper 2014 was highlighted by the journal

White's paper published in Chemical Communications 2015 was cited as one of the top 1000 papers in chemistry in 2015

Harbige was a visiting scientist at Universidad Autonoma del Estrado de Mexico.

White was a Visiting Fellow at Aligarh Muslim University, India April 2019.

Meimaridou won the New Investigator Oral Communication Award at the 17th Adrenal Cortex conference (Boston), 2016.

Sil was nominated for the Emerging Scientist Award 2019 of the Academy of Pharmaceutical Science (APS).

Terry was awarded the Tony Ball Memorial Prize for Outstanding Research on Prion Diseases from UCL, has won three awards from the MRC for contributions to public engagement activities (2015, 2017, 2018), and won a Technical Merit Prize Award for Overall Best AFM Image (AFM workshop, Porto 2016).

Membership of research committees or trusts

Ghoddusi is a member of the Advisory Committee on Novel Foods and Processes (ACNFP) of the Food Standards Agency since 2016, and of the Panel on Food Contact Materials, Enzymes and Processing Aids, European Food Safety Authority since 2018.

Harbige is a member of the scientific and executive committee of the International Society for Immunonutrition.

McCarthy was a Course Accreditation Committee Member for the Association for Nutrition.

McLaren is a trustee of the Caroline Walker Trust (<https://www.cwt.org.uk/who-is-involved>)

Meimaridou was STEM Ambassador in the Centre of the Cell, Queen Mary University London.

Sil is Co-Leader of the Skin Forum focus group of the Association for Pharmaceutical Sciences of Great Britain (<https://www.apsgb.co.uk/focus-groups/skin-forum/skin-forum-who-we-are/>).

Terry is a member of the Scientific Committee of the British Brain Bee, a national charity affiliated to the International Brain Bee, which organizes the world-wide neuroscience competition for high school students.

Terry is also a STEM ambassador for the Biochemical Society and the Royal Society of Biology and is also a professional registration assessor for the Science Council.

Webb is on the Cancer Expert Group for the Faculty for Sport and Exercise Medicine & Public Health England Moving Medicine; on the Expert Advisory Group of Versus Arthritis.

External PhD Examining / Review of Promotions

Six staff have examined 14 PhDs from 11 institutions including 2 internationally.

Three staff have served as external reviewers of promotions in 9 institutions, including 3 internationally.

Consultancies

McLean consulted for Prokarium Inc 2016-17 and CureVac GmbH 2016-17.