Institution: London Metropolitan University

Unit of Assessment: UoA 3

a. Overview

This submission brings together the work of four research clusters; namely, Cellular and Molecular Immunology Research Centre (CMIRC), Lipidomics and Nutrition Research Centre (LNRC), Molecular Systems for Health Research Group (MSHRG***)*** and Public Health Nutrition Research Group (PHNRG). These groups are the result of the University-wide strategic research review conducted by London Metropolitan University in November 2011. The reorganisation has enabled the Faculty to: (1) Build on its key strengths by consolidating expertise and resources, (2) Conduct innovative basic and applied research in the areas of human health and welfare, (3) Promote collaborations with national and international research centres of excellence, industry and societal stakeholders.

In the last census period, the University demonstrated its commitment to research and innovation by investing £30 million in the 'Science Centre' building to provide state-of-the-art facilities for science education and research. Since 2008, the University made a further investment in a backup generator, new compressed air and nitrogen central piped facility and equipment (new and replacement) confirming its continued dedication to research.

Highlights of the census period (2008 -2013)

- Research income generated increased from £175,000 (RAE 2008, UoA 12) to £1,313,952 (REF 2014, UoA 3). Up 750%.
- PhD completions 23 compared with 14 in 2008 (Up 164%). Current number of PhDs 33.
- Full-time PhD Fellowship given to 11 graduate students (In RAE 2008, none)
- Expanded collaborations with national (12) and international institutions of excellence (over 35)
- Number of substantive peer-reviewed (110) international conference (72) publications
- Foreign post-doctoral researchers hosted (10)
- International conference hosted and partly supported (4)

CMIRC *(Heugh S, Inal J, McLean G, Palmer C, Scott-Taylor T & Stratton D*) aims to understand: (i) Cellular and molecular basis of extracellular vesicle (EV) involvement in infectious disease and biogenesis/metastasis of cancer and to develop effective interventions by using EVs as targeted therapeutic agents; (ii) Ion channel signalling and their contribution to cellular physiology and pathology with the specific focus on the role that ion channels play in metastatic cancer. CMIRC collaborates with industry and clinical researchers to translate the findings of its basic and applied research into clinical applications. During this census period, the group has published 29 original papers, 32 international conference abstracts and supervised 5 PhDs to successful completion.

LNRC (*Ghebremeskel K, Hussein I, Min Y & Sedlak E*) has distinct expertise and experience in lipid biology and nutrition accumulated over many years of research and post-graduate training. The research remit of the group is to elucidate the role of circulating and membrane lipids in growth and development, health and disease. Consistent with this remit, the centre has: (1) Conducted several basic, applied and translational (ISRCTN68997518; ISRCTN80844630; ISRCTN93233285; ISRCTN20233876) studies; (2) Published 40 peer-reviewed and 28 international conference papers; (3) Supervised 8 successful PhDs and 6 more are expected to finish in the next two years; (4) Organised/co-organised 3 international conferences – *"International Conference on the Economic Importance of Fisheries and their impact on health"* (Grand Hyatt, Muscat, Sultanate of Oman, 8 -10 March, 2008); *"Intervention Strategies to Challenge in the Rise of Mental Ill Health"* (London Metropolitan University, 8 and 9 September, 2010) and "*A Celebration of DHA Discovery, Achievement and Challenges 40 years on*" (Royal Society of Medicine, 26 and 27 May 2010).

MSHRG *(Chatterton N, Fairbrother U, Shearman G, Smith E, Sykes D & White K)*. The main research areas: (a) Nano-formulation of drug delivery, (b) Novel lipid vehicles for drug delivery, (c) Phytomedicines, and (d) Metal agents biology. The group has extensive international collaborations and its research focus and activities were commended in RAE 2008. During this census period, MSHRG published 37 peer-reviewed papers, 12 international conference abstracts and supervised 5 PhDs to successful completion.

PHNRG (*Bhakta D, Ghoddusi H, Hayes L, McCarthy D & Sutherland J*) – Some members of

PHNRG have been part of this institution's submission to Subjects Allied to Medicine since 1996. Over the following 17 years, they sustained its core presence in health-related research within the institution. Obesity assessment, causation, management and how obesity relates to risk for metabolic disease, and nutrition policy and practice are the major research foci. One of the key objectives of the group is to help address the university's policy on promoting research in health inequalities as part of a wider mission on social justice. An impact case study has resulted from the research conducted by the group. PHNRG has supervised 5 PhDs to successful completion and published 20 peer-reviewed papers.

Research management

Consistent with the corporate plan of London Metropolitan University, the Research Committee of the University is responsible for the development of research and enterprises strategies, setting research directions, monitoring research performance across the University and other research matters. Research activities and direction, collaborative and funding opportunities, resource allocations, staffing and other research-related issues are discussed and evaluated, as appropriate, biannually by the Research and Enterprise Committee of the Faculty chaired by the Dean, quarterly by the School Research Steering Group chaired by the Head of the School and weekly by the research group. Advice and support on funding opportunities, research bid, costing, project management, financial reporting and auditing and intellectual property are provided by the Research and Postgraduate and Financial Offices of the University.

b. Research strategy

The general research strategies of the Faculty and submitting unit during this census period were to maintain and develop distinctive research expertise, forge and sustain multi-disciplinary collaborations, promote and support translational research activities and engage with stakeholders in public health. These strategies are vital for sustaining and promoting a vibrant and productive research environment. To advance basic and applied knowledge which helps promote human health the four research groups will undertake the following research:

CMIRC will investigate:

- Cellular and molecular basis of extracellular vesicle (EV) involvement in infectious disease and cancer biogenesis/metastasis;
- The potential of stem cell-derived EV as targeted therapeutic agents. The focus will be viral infection (coxsackie and rhinovirus);
- The use of EV in acute kidney injury. Live kidney slice model will be used to unravel the role of EV in kidney injury and inflammatory pathways involving TNF-like weak inducer of apoptosis (TWEAK) and fibroblast growth factor-inducible molecule 14 (Fn14);
- The role of Sigma-1 receptors in colon and ovarian cancers.

LNRC – The study conducted during this census period demonstrated that omega 3 fatty acids are effective in reducing voso-occlusive and haemolytic crises in patients with homozygous sickle cell disease. The group will conduct follow-up studies to:

- Assess the response of sickle cell patients with different haplotypes (Benin, Cameron, CAR/Bantu, Senegal and Saudi Arabia/India) to the therapy. We have established a research consortium consisting of researchers and clinicians from UK, USA, Congo, Nigeria, Senegal, Sudan and Uganda to address the question (the consortium which is called **F**orum for **A**dvancement of **R**esearch, **A**wareness and **T**reatment of Sickle Cell Disease in **A**frica (**FARATA**) has already submitted a grant proposal to the National Institute of Health, USA);
- Elucidate the mechanism through which omega 3 fatty acids ameliorate vaso-occlusive and haemolytic crises. The focus of this investigation will be the bio-active lipids - prostacyclin (PGI2), thromboxanes (TXs), leukotrienes (LTs), lipoxins, resolvins and protectins. Other non-lipid inflammatory markers, adhesion molecules, nitric oxide and foetal haemoglobin will be measured;
- Investigate if Omega 3 fatty acids ameliorate silent and overt stoke and cognitive function in young children with the disease. Clinical evaluation, electroencephalography (EEG) and magnetic resonance imaging (MRI) will be used to evaluate efficacy. Ethical approval has been obtained for this study.

MSHRG established a new electrospinning facility for nano-fibre development for biomedical applications. The work has attracted funding from HEIF and a patent application, production of biomedically useful biphasic side-by-side fibres, is being prepared with a view to seeking

commercial partners to exploit the technology. In addition, the biphasic fibres will be developed for biphasic drug and enhanced trans-dermal drug delivery and novel scaffolding for 3D cell culture models. The fibres for drug delivery include phospholipid and create nanoparticles on exposure to aqueous environments, by self-assembly. The group aims to develop novel lipid delivery systems, based on and/or incorporating lipid phases (both lamellar and non-lamellar). Such systems have potential biomedical applications as well as in neutraceuticals, agrochemicals and cosmetics. The promising collaborative work with Qom University of Medical Science (Iran) on 4-hydroxyisoleucine, an anti-diabetic component of fenugreek, which has been very productive will be extended. Later this year, we will host a post-doctoral researcher, financed by the Government Iran. The group's expertise in metal chelation, following the successful development of a pH sensor currently being reviewed for a patent, will focus on the development of fluorescent ligands with sensor capabilities.

PHNRG shall conduct investigations which would enable us to:

- Further characterise the skeletal muscle and adipose tissue masses in children from South Asian and African-Caribbean backgrounds with the aim to develop better clinical and surveillance assessment tools in these population groups;
- Determine the impact of patterns of infant and childhood growth on the partitioning of energy and nitrogen into skeletal muscle and adipose masses and how this impacts upon risk for metabolic disease and risk for sarcopenia/sarcopenic obesity;
- Produce an assessment tool for parent and clinical use to identify children from South Asian background who are at risk of overweight/obesity and metabolic risk;
- Evaluate the impact of diet and lifestyle interventions on body composition and blood measures of metabolic disease.

c. People, including:

Staff retirements and changes in post have resulted in the appointment Palmer C, McLean G, Shearman G (experienced researchers) and Hayes L (early career researcher). Eleven 'Category A staff' (Chatterton N, Ghebremeskel K, Hayes L, Inal J, McCarthy D, McLean G, Min Y, Palmer C, Shearman G, Sykes D and White K) are included in this submission. The research activities of the groups are supported by post-doctoral researchers, senior and junior technical staff and PhD students.

Chatterton N (Senior Lecturer in Chemistry since 2007) developed his research interests into the development of novel drug delivery systems using the approach of electrospinning to generate nanofibres. This collaborative work with Dr Gareth Williams (School of Pharmacy, UCL) and Dr Deng-Guang Yu (University of Shanghai for Science and Technology) has generated 10 peer-reviewed publications and an invited review since 2010. Additionally, he has continued his work into luminescence molecular sensors which has led to one patent application and two journal articles. Chatterton presented an invited paper titled "*Electrospun nanofibers: facile to prepare but effective potential anti-cancer agents*" at the 5th International Conference on Molecular Materials in Barcelona (July 3-6, 2012) and has acted an ad-hoc reviewer for Colloids and Surface B: Biointerfaces.

Ghebremeskel K (Professor of Lipid Biology since 2002) consolidated his international status as one of the leading researchers in lipid biology by: (1) conducting five intervention studies (ADHD, Asperger's syndrome, Multiple Sclerosis, Sickle Cell Disease and Healthy School Children); (2) co-organising four international conferences (two in London, UK and one in Muscat, Oman). In the conference on "Discovery, Achievement and Challenges for Global Health 40 years on", which was held at the Royal Society of Medicine, London (May 26&27, 2010), the pioneers of Lipid biology, Professors Nicolas Bazan (Neuroscience Centre, Louisiana State University), Claudio Galli (University of Milan), Andrew Sinclair (Metabolic Research Unit, Deakin University, Australia) and Rodolfo R. Brenner (Institute of Biochemical Research of La Plata, Argentina) were the keynote speakers; (3) collaborating substantially with ten international research groups. Ghebremeskel is an ad hoc reviewer of several international journals and grant-giving bodies, and a member of International Scientific Advisory Board of Vifor Pharama (since June 2010).

Hayes L (Lecturer since 2012) is a bright early career researcher with broad interests in nutrition and sports medicine. At present, he is investigating the effects of lifelong exercise and nutrition on physiological decline in ageing males. He has published nine peer-reviewed papers as first author and presented at the European Colleague of Sports Science annual congress in Barcelona in 2013.

Inal J (Professor of Immunology since 2007) is one of the leading investigators in the field of Extracellular Vesicles Research. He has conducted several multidisciplinary collaborative investigations with colleagues in the UK and beyond and published over 20 peer-reviewed papers during this census period. Inal is Editorial Board Member of the Journal of Extracellular Vesicles (2012-), Associate Editorial Board Member of American Journal of Clinical and Experimental Immunology (2012-), Editorial Advisory Board member of The Open Parasitology Journal (2008-) and Editorial Advisory Panel Member of the Biochemical J. (2006-09) He is an ad hoc reviewer of Journal of Immunology.; Clinical and Experimental Immunology, Scandinavian Journal of Immunology, Parasitology; Experimental Parasitology, Virus Research and Medical Microbiology and, and ad hoc Grant Reviewer for MRC; Wellcome Trust; Swiss National Foundation and Netherlands Organization for Scientific Research. Inal organised an international conference on ''Microvesiculation and Disease' at London Metropolitan University between 13th-14th September, 2012, and he was a key note speaker. Recently, Inal with a consortium consisting of SMEs and academic researchers, submitted a grant proposal, "EVEStemInjury" to the EU; it has passed the initial evaluation stage with a score of 88.2%.

McCarthy HD (Professor of Nutrition & Health since 2008) has maintained his national and international profile in the discipline, as evidenced by a number of invited lectures to universities and scientific meetings. He has brought his specific expertise in obesity and body composition to wider audiences including appearing in two TV series on weight loss for Sky TV and the construction and marketing of a new child's doll based on his research into body composition in children. In addition he is regularly asked for his expert comment in the media on matters relating to childhood obesity and nutrition and his research often features in the press. He has conducted a number of cross-sectional studies into body composition of children of different ethnicities and weight management intervention studies with obese youths. McCarthy collaborates internationally with researchers and health care practitioners in the UK, USA (New York), Malaysia (Kuala Lumpur) and several European Countries. He is an ad hoc reviewer for a number of international journals in the obesity, public health and paediatric disciplines.

McLean G (Reader since April 2013) is an expert in human viral infections and associated immune responses and pathophysiology. His research focuses on two human viral pathogens, rhinovirus (RV) and cytomegalovirus (CMV) investigating antibody responses, the development of vaccines and the role of microvesicle release in the spread of infection. He has an H-index of 9 and published 21 peer-reviewed scientific papers in leading immunological and biomedical journals, more than half of these as first author, seven as corresponding author and three as senior author. McLean collaborates with researchers in continental Europe, Canada and USA.

Min Y (Senior Research Fellow since 2008) research interests include membrane lipids and cell function, lipids and foetal and neonatal development and polyunsaturated fatty acid metabolism in pregnancy complicated with diabetes. At present, Min is conducting an intervention study with omega-3 fatty acids in pregnant women with type 2 and gestational diabetes. She has given presentations on diabetes and essential fatty acids at international conferences held in Belgium, Denmark, Hungary, Japan, Korea, Portugal and USA. Min has published 22 peer-reviewed papers, 3 book chapters and over 20 conference abstracts.

Palmer C (Professor of Membrane Signalling, since 2012) joined the University in 2008 as a Senior Research Fellow/Senior Lecturer. Since then, he has established a very productive research area pertaining to "Cell and Membrane Signalling". Palmer's current projects include: ion channels and their involvement in cancer; polycystic kidney disease; ion channels in yeast and pathogenic fungi; modulation of ion channels by Sigma receptors; and systems biology of cation transport in yeast. In 2009, he forged collaborations with Scientists from European Universities which has resulted in the award of a 2.4 million Euro grant and become a member of a powerful and diverse research consortium in the topical area of systems biology. Palmer was promoted to Reader in Molecular membrane signalling in 2011 and to Professor in 2012.

Shearman G (Lecturer since 2012) has broad research interests across the field of liquid crystals; however, her research focuses on the polymorphism, bilayer mechanics and applications (e.g. as targeted delivery systems) of lipid-based lyotropic liquid crystalline systems and their applications. She has published ten peer-reviewed papers in these areas during this census period with seven of these being as first author, and was also invited to present at the international Semibiotic Systems conference, Malta 2008.

Sykes D (Lecturer since 2013) research interests are in luminescent molecules and their diverse

applications from emissive materials to cell imaging. His current research focus is on lanthanide complexes and their potential in the control of the generation of light. He has published 12 peer-reviewed papers (cited 300+ times) in this area, including an invited book chapter. In 2011, Sykes presented some aspects of his research at the ACS spring conference in California, USA.

White K (Reader since 2011) research interests are broad and in recent years he has helped establish the electrospinning facility for production of biomedically useful nanofibres (current project with one research assistant funded by HEIF). His other areas of research include: characterisation of new phytochemical anti-diabetic compounds (currently 3 PhD students and collaborations with Iran); and characterisation and medical applications of ferroxidases in iron homeostasis (one PhD student; collaboration with Brunel University). He is also a member of the cross-faculty Bioinformatics Research Group, and has co-supervised two PhD projects on proteomic applications. White is an ad-hoc reviewer for mainly phytochemical journals and has reviewed grant applications for the BBSRC, MRC and research charities, has co-authored 21 peer-reviewed publications and given 16 oral and poster presentations at international meetings during this assessment period.

i. Staffing strategy and staff development

Staffing and staff development strategies are central for maintaining a critical mass of investigators and productive and sustainable research environment. With this in mind, researchers who retire or move to another institution are replaced as a priority and new investigators are recruited when funds are available. During this census period, Professor Chris Palmer, Dr Gary McLean, Dr Gemma Shearman and Dr Sykes D (experienced researchers) and Drs Lawrence Hays and Dan Stratton (early career researchers) with a track record of research and publications have been recruited.

Our staff development strategy encompasses promotion, training, support and mentoring. *Promotion* - Since RAE 2008, the following investigators have been promoted in recognition of their outstanding research: Drs Chris Palmer and David McCarthy (Reader to Professor) and Drs Kenneth White and Gary McLean (Senior Lecturer to Reader). *Support* – Start up funds to cover the costs of consumable is provided to early stage investigators. In the financial year 2009/2011, £50,000 was distributed among three young researchers. A number of our senior investigators are allocated time to conduct their research work. *Training* – Researchers are seconded to collaborators' institutions to learn specialised laboratory skills, gain hands on experience on the use specialised instruments or conduct experiments. Drs Yoeju Min (08/2008 to 01/2009) and Yiqun Wang (09/2009 to 02/2010) were seconded to Professor Holm Holmsen's laboratory, University of Bergen, to learn methods and preparation of lipid monolayer and operation and control of Differential Scanning Calorimetry. In addition, Dr Min was sent to Professor Tomas Brenna's Laboratory, Cornell University, to train in techniques of Isotope-ratio Mass Spectrometry. *Mentoring* – Early career researchers are mentored by senior colleagues by involving them in on-going research and writing of grant applications. Funds are provided to junior and senior researchers to attend internationals conferences. In addition, the developmental needs of staff are identified during annual appraisal and are acted upon.

ii. Research students

During this census period, 23 students completed their PhDs successfully and all of them are now working with educational institutions (post-doctoral researchers, lecturers) or with companies in the UK or abroad. The corresponding number of completions in RAE 2008 was 14. At present, we have 33 PhD students at various stages of their training and are progressing very well. Of these, eleven are on a full-time PhD Scholarship (£13,000/year) granted by London Metropolitan University (Vice Chancellor's Fellowship). New PhD students are usually embedded in on-going research programmes to help facilitate their integration with research teams. Progress is monitored during the weekly research group meeting at which PhD students provide an update of their research. In addition, it is scrutinised by the Health Science Research Steering Group (Chaired by Head of School) and Faculty of Life Sciences and Computing Research Student Progress Group (Chaired by Faculty Dean). PhD students are required to actively participate in the bi-weekly seminars and to give oral or poster presentations in the conference of PhD students organised by the School every year. They are encouraged to attend national and international conferences and whenever possible funds are made available to help them do so. Support was given to PhD students to attend international conferences uch as: ISSFAL 2008, Kansas City; FEBSC 2009, Prague, Czech Republic; ISSFAL 2010, Maastricht, Belgium; Muscat, Oman, 2008;

Forum of Fat and Health 2010, Benixi, China; ISSFAL 2010, Maastricht, Belgium; ISSFAL 2010, Maastricht, Belgium; 97th Immunology meeting, Baltimore, 2010; 99th Immunology meeting, Boston, 2012; and 1st (Gothenburg, Sweden, 2012) and 2nd (Boston, USA, 2013) meeting of the International Society for Extracellular Vesicles.

d. Income, infrastructure and facilities

Income - During this census period, the submitting research team obtained £1,313,952 research grant from charitable trusts, an overseas government, a research council and industry. The sources are: Almased Wellness (£150,000), BBSRC (£300,912), Dunhill Medical Trust (£54,216), Efamol/Wessen International (£15,000), Emerald grant (£10,000), Higher Education Innovation Funding (£19,720), Ministry of Agriculture and Fisheries Wealth, Sultanate of Oman (£192,830), North Central London Primary Health Trust (£30,000), Mother and Child Foundation (£269,000), Tanita EU (20,000), Sir Halley Stewart Trust (£27,207) and Vifor pharma International (£150,082). Research income in-kind – 500,000 capsules from Efamol /Wessen International for sickle cell. The research funds generated this time is 7.5 times higher than the amount reported in our submission to UoA 12 in 2008.

Infrastructure – The University invested £30 million in the 'Science Centre' building to provide state-of-the-art facilities for science education and research. This major investment in infrastructure, which reflects the commitment of the institution to research and innovation, has enabled the research groups to realise their potential.

The third floor of the building supports the largest science teaching laboratory in Europe and has the necessary facilities for undergraduate and masters degree students. The three research groups (CMIRC, LNRC & MSHRG) are housed in well-equipped large open plan laboratory located on the second floor of the building This open plan laboratory with shared facilities provide a very conducive environment for stimulating scientific interactions, collaborations, informal training of laboratory skills and mutual support. The laboratory has facilities for genomic, proteomic, lipidomic, metabolomic, cellular and molecular immunology and molecular membrane signalling research and for organic synthesis and phytochemical extraction and analysis. The laboratory has access to three adjacent rooms that are purpose built for cell culture, food microbiology and a biosafety level III suite for virus related investigations.

Research facilities - *Flow cytometry facility* - 2 flow cytometers: Guava® easyCyte™ 5HT with sample loading from 96-well format and Guava® easyCyte™ 5 with sample loading from single tubes. The facility is able to carry out the following assays: cell cycle analysis; apoptosis, intracellular protein detection, proliferation, calcium influx and phenotyping. *Imaging facility* - Nikon inverted TS100; Olympus upright 1X81 motorised fluorescence microscope with Electric CO_2 Microscope Stage Incubator and time lapse microscopy and image processing and analysis. *Recombinant technologies facility* – There is facility for expressing recombinant proteins in bacteria or mammalian cells on a small scale for *in vitro* experiments, and protein purification with an ÄKTAprime system. siRNA knockdown of protein expression in mammalian cells is also carried out. *Molecular Analysis facility:* Quartz Crystal Microbalance (Q-Sense E1) for sensitive measurement of mass change indicating MV release from cells in real time or for cell attachment, protein interactions (K_D estimations, similar to surface plasmon resonance); Fluorescence Spectroscopy; Mass Spectrometry; PROTEAN® II XL Cell and mini- PROTEAN II cells; semi-dry transfer system and UVP ChemiDoc-It® Imager; FLUOstar Omega plate reader (BMG LabTech); a patch clamp electrophysiology set up; a two electrode voltage clamp set up; X-ray powder diffractometer. *Lipidomic, metabolomic, proteomic and trace element facility*: 500 MHz Bruker NMR spectrometer; Quadrupole Time-of-Flight Mass Spectrometer; Matrix Assisted Laser Desorption/Ionization Time-Of-Flight Mass Spectrometer; Gas Chromatograph-Isotope Ratio Mass Spectrometer; Ion Trap Gas Chromatograph-Mass spectrometer; Inductively Coupled Plasma-Optical Emission Spectrometer. The latest BioRad assemblies are available for 2D gel analysis including the PROTEAN II xi cell and PROTEAN II XL wide-format cell. The Public Health Nutrition research group is located on the ground floor of the Science Centre building. The infrastructure essentially comprises of wet and dry laboratory with excellent research level equipment and facilities, and the nutrition/obesity laboratory which is equipped with body composition measurement facilities. It includes air displacement Plethysmography, Bioelectrical Impedance Analyser, BodyGem Indirect Calorimeter and Dual Energy X-ray Absorptiometry. The latter has enabled the group to validate clinical and field-based body composition assessment tools against a 'gold standard' or reference technique and to extend their body composition

research beyond soft tissue to bone and mineral evaluation. The Indirect Calorimeter enables determination of energy expenditure and requirements for healthy and obese individuals. The laboratories are managed by the Science Centre Coordinator in collaboration with senior researchers and the Head of the School. The costs of maintenance and replacement of instruments are underwritten by the School.

e. Collaboration or contribution to the discipline or research base

The members of the research groups have collaborated substantially with investigators from 10 UK and 22 international research institutions. Some of the national collaborators are: Professor K Rubia (Institute of Child Psychiatry, London), Professor O Djahanbakhch (Obstetrics Department, Royal London Hospital), Dr S Jabb (MRC Human Nutrition, Cambridge), Drs A Wiskin and S Wootton (University of Southampton, Medical School), Professor R Evans (Health Science and Social Care, Brunel University), Professors J Brooks and N Seddon (Chemical Physics Section, Imperial College), Professor S Johnston (Airway Disease Infections, Imperial College), Dr S Lange (Institute of Women's Health, University College London). The international collaborators include: Professor T Brenna (Division of Nutrition, Cornell University), Professor H Holmsen (Biomedicine, University of Bergen), Professors Mustafa El Bashir and Ammar Eltahir Ahmed (Faculty of Medicine, University of Khartoum), Professors A Berg and D Koeing (Univsitatsklinikum, Freiburg, Germany), Professor T Wolanczk and Dr B Kozielec (Department of Child Psychiatry, Medical Academy of Warsaw, Poland), Dr I Patrikos (Cyprus Institute of Neurology and Genetics, Cyprus), Professor R Reifen and Professor E Yavin (The Hebrew University of Jerusalem and Weizmann Institute of Science, Israel), Dr A Mola (Rusk Institute of Rehabilitation Medicine , New York University, USA), Professor J Schrader (Biomedical Research Centre, University of British Colombia, Canada) and Dr M Ramirez (Instituo Oswaldo Fiocruz, Rio De Janiero, Brazil). Palmer C, Ghebremeskel K and Inal K are members of the Eu Translucent 2, Eu EVEStemInjury and FARATA consortium, respectively. Collaborating companies include: Tanita Eu, Efamol/Wessen International, Seven Seas, Equazen UK, Fresenius Medical Care Italia S.P.a (Italy), Vifor Pharma International, etc.

Contributions to the discipline or research base

During this assessment period, the research groups have conducted a considerable number of novel multidisciplinary studies which contributed to the advancement of research and human health. The following investigations and findings illustrate some of the contributions to the relevant research areas.

- LNRC demonstrated that the omega 3 fatty acids, eicosapentaenoic and docosahexaenoic, are effective in preventing vaso-occlusive and haemolytic crises. This new evidence of the role of the fatty acids in the improvement of vascular and haematological function in sickle cell disease has profound implications for the development of omega-3 fatty acid-based therapy and the management of patients with the disease.
- PHNRG, consistent with the NICE guidelines, developed a further set of childhood clinical charts – specifically to assess total body fatness. These new charts substantially reduced the risk of misclassifying children compared with BMI whilst at the same time focusing attention away from excess weight which was a sensitive issue for children and their parents. This is an original contribution to obesity research and public health practice.
- CMIRC established that intracellular microorganisms induce host cell MV release, enhance invasion and protect the infectious agent during its crucial period between accessing the organism and subsequent intracellular invasion by inhibiting host complement and providing host TGF-β1 which enhances invasion. This finding is a major contribution to the new area of MV research which has come to the fore in the last five years.
- MSHRG has developed co-axial electrospinning methods for production of biomedically useful nanofibres, in which a fibre core, containing a poorly soluble drug is enveloped in an outer sheath. By using lipids in the outer sheath it is possible to induce self-assembly of nanoparticle lipid vesicles with drug inside when the fibres make contact with an aqueous solution, and produce a very efficient mode of delivery of poorly soluble drugs.