Institution: **King's College London**

Unit of assessment: **C26 – Sport, Exercise, Leisure and Tourism**

a. Context:

The Centre of Human & Aerospace Physiological Sciences (CHAPS) is a Research Division at King's College London (KCL). Its research focuses on human physiological function, performance and adaptation. It is centred on three overlapping research groupings in which exercise and ageing are cross-cutting themes.

Our work is highly topical and relevant to current health issues in society, particularly those pertaining to exercise and the context of an ageing population. It has clear relevance to the increasing population with lifestyle and particularly inactivity-related diseases (obesity, cardiovascular disease and type 2 diabetes).

CHAPS is positioned at the nexus of basic mechanistic biomedical, clinical and applied human sciences with the dual purpose of increasing understanding of the human body and improving health and physical performance across the lifespan. Our research is both multi- and inter-disciplinary with approaches ranging from fundamental cell biology to applied whole body physiological function and benefits from access to novel experimental environments. We work with a variety of partners; internally, nationally and internationally. Our research has impact far beyond scientific publication and the academic community. Our Drug Control Centre (DCC) is the UK's only World Anti Doping Agency (WADA) accredited testing laboratory for the detection of prohibited substances used by athletes. It tests athletes and also researches new detection methods using the latest analytical chemistry techniques.

Our commitment to translational research can be seen in collaborations with groups across KCL. We work with King's Health Partners (KHP, the Academic Health Sciences Centre coupling KCL with the three largest NHS hospital trusts in South London) and with numerous other national and international partners. Our collaborative research programmes have external partners in a diverse range of areas, with beneficiaries including health service providers and users, policy makers, industry, the military, aerospace and sporting communities and the general public.

Our research has wide impact ranging from ordinary members of the public, to elite athletes, patients with a wide range of clinical conditions and to those striving to push forward the frontiers of human endeavour. We have six pathways to impact which are outlined below.

b. Approach to impact:

i) Clinical partnerships: We work closely with clinicians, patients and members of the general public. A number of research projects are collaborative ventures between our academics and clinical partners, who are frequently joint applicants on grant applications. We are involved with clinicians in a number of specialities including critical care, respiratory medicine, geriatrics/gerontology, rheumatology, cardiology, regenerative medicine, neurology and rehabilitation. One area of particular interest is muscle wasting. Both our basic and translational research explores underlying mechanisms and the efficacy of therapeutic interventions. In collaboration with EU Framework 7 partners, this extends to clinical trials planned for 2014 to determine the efficacy of cardiac stem cells in repair of the heart.

ii) Partnerships with industry, aerospace and military communities: With GlaxoSmithKline (GSK) we have established collaborations though both CASE studentships (EPSRC) and formal Industrial Partnerships on grant applications (BBSRC). As outlined below, we also work more broadly with GSK in regard to the DCC and our outreach programmes. We also have an active collaboration with Imanova (GSK) & General Electric (GE) examining the use of second-generation PET ligands to assess the role of microglia in the generation and maintenance of neuropathic pain. Other examples of industrial partnerships include work with XSens to help develop inertial measurement units for portable motion analysis systems and Acetegy to develop High Frequency Airway Occlusion (HFAO) for respiratory pathologies.

Our research in aviation physiology and medicine is concerned with both passenger health during commercial flights and the performance of fast jet pilots. Ongoing studies with the RAF

and Qinetiq are evaluating the physiological challenges provided by the increased manoeuvrability of the UK's Typhoon jet aircraft. Each year with our MSc students we undertake a collaborative research project at the RAF Centre of Aviation Medicine (RAF CAM) which targets an operationally-relevant problem identified by the RAF. With the European Space Agency (ESA) we are developing elasticated skin suits for use by astronauts on the International Space Station (ISS) to help prevent physical deconditioning.

iii) Influencing policy and practice: Our members make a vital contribution to the development of public health policy and excellence in professional practice. The results of our research can be found in wide variety of organisations and caring environments. Anyone who flies is safer because of our work. Our Professor of Aerospace Medicine (Gradwell) has been instrumental in developing national and international guidelines for passenger safety during commercial airline flights. Work on the vascular effects of sitting at the usual altitude for eight hours has been incorporated into international guidelines for airline passenger safety. Some of our clinically related work has been accepted into routine practice both locally and nationally. The physical management of patients suffering visual vertigo (Case Study 1), falls (routine screening for vestibular pathology in people attending Falls Clinics at Guy's & St Thomas' Hospitals and local GP practices) and we have contributed to the government agenda of the recognition, education and management of persistent pain (www.painsummit.org.uk).

iv) Sporting Community links: The DCC is at the centre of the international sporting community, having enormous impact through testing blood and urine samples for both UK and international sports bodies. This ongoing work, culminated in the successful delivery of the drug testing programme for the London 2012 Olympic and Paralympic Games (*Case Study 2*).

v) Public involvement & engagement: We are passionate about sharing our work and use a variety of approaches to increase public knowledge and awareness of our research. We are also actively engage with stakeholders to inform study design.

Clinically related studies e.g. stroke rehabilitation and falls management, involve users (patients, carers and health service providers) from an early planning stage so that our research is both feasible and valuable. Our work is recognised in the self-help material produced for the lay public by medical research charities e.g. Research into Ageing and Arthritis Research UK.

Our staff have taken part in a number of television and radio programmes in addition to giving public lectures and seminars. These include TV programmes e.g. "The Secrets of Everything", "Stargazing Live", "Bang goes the Theory", "Newsnight" and numerous contributions during the 2012 Olympics - particularly with regard to the work of the DCC. Our researchers have given numerous prestigious public engagement lectures such as at the Kielder Observatory and the Cheltenham Science Festival as well at innovative regional events such as "Pint of Science".

vi) Outreach: We work hard to share our research and expertise with young people to increase knowledge and enthusiasm about science. With GSK and KCL's STEMNET ambassador programme we instigated, piloted and ran the "Scientists in Sport" (www.scientistsinsport.com) programme. It ran six times at KCL, reaching more than 400 children, and was taken to six other institutions. KCL and GSK subsequently expanded the programme to include a national anti-doping challenge with 400 registered teams. This won the gold medal in the 'Get Set Award for Inspiring Learning' category at the 2012 Podium Awards. In addition Prof Cowan has addressed 3 groups of around 900 sixth form students at various locations around London as part of the Chemistry in Action programme.

For the past two years we have worked closely with the International Space School Educational Trust hosting "Mission Discovery" (www.kcl.ac.uk/biohealth/study/outreach/summerschool.aspx). This week long summer school for >200 children has the mission of each team of six designing a scientific experiment to be undertaken on the ISS. This was in parallel with a number of integrated scientific learning, team and confidence building activities. With active supported from KCL's widening participation scheme, K+, students interact with former NASA astronauts, CHAPS academics and have video lectures from NASA scientists. Former astronaut Ken McCulley described Mission Discovery as "*by far the most comprehensive, interesting, and educational endeavour that I have been involved with*". In December 2013 the winning

experiment will launch to the ISS, allowing the children to continue to interact with this programme. We have also organised and hosted lectures to children in our partner schools e.g. Harris Academies, given by former NASA astronauts using human space flight as a conduit for increasing enthusiasm for STEM subjects, as well as supporting a number of Mission X activities targeted at schools and the general public.

c. Strategy and plans: Impact has been embedded in the strategy of CHAPS since its formation in 2010 and evidence of the delivery of our impact strategy is demonstrated in the six pathways to impact outlined above. Moving forward, we plan to develop further these themes. In particular we see our strategy as having a particular focus on our engagement as below:

i) Sports community: The DCC will continue its work on the development of new methodologies for the detection of prohibited substances as a WADA-accredited testing facility for sports in the UK. It will provide support for the 2014 Commonwealth Games in Glasgow and for the 2016 Olympic and Paralympic Games in Rio de Janeiro.

ii) Aerospace Community: CHAPS was the first academic institution outside the US to become a member of NASA's Human Health & Performance Centre. This virtual forum was established to connect international organisations interested in collaborating to advance human health and performance. Other members include NASA centres and international partners.

We are a core and founder member of the recently formed "UK Space Biomedical Consortium" - brought together by academics, industry and the UK Space Agency. This expanding consortium, which now has over 30 partners, is the vehicle for collaboration between academic, industrial and governmental organisations. Its remit is to focus on health-related issues pertaining to space flight and particularly on how this research can benefit Earth–bound problems e.g. osteoporosis and sarcopenia. This body has already had considerable impact, persuading the UK government, for the first time, to join ESA's European Life & Physical Sciences (ELIPS) programme. As part of this venture CHAPS hosted a workshop in 2012 involving the Research Councils. The outcome was commitment by the BBSRC to allocate funds to support space-related bed-rest studies. Furthermore, our expertise in aerospace science and medicine puts us in a pivotal position to influence policy and practice in the emerging field of "space tourism"

iii) Partnerships with industry: Our work on muscle (both skeletal and cardiac) stem cells has attracted the interest of pharmaceutical companies e.g. GSK, AstraZeneca and others (including Philips Medical Systems, Genetrix, InBiomed, Xcelia & Innocore) through our EU Framework VII partners. We plan to actively develop these collaborations and cement new ones i.e. with Imanova and GE regarding the development of novel PET ligands for pain research.

Our impact strategy is built on a research platform which is informed by early engagement with key stake holders. We will continue to support and encourage impact through a structured approach which includes regular reviews to identify strengths, weaknesses and opportunities.

d. Relationship to case studies: Our research is integrated in three main themes with significant impact arising from all. The chosen studies reflect the diversity of our research impact on different communities. The first originates from our Sensory Motor Control & Pain group and demonstrates the impact of our research on clinical practice. Dr Pavlou's work on visual vertigo, a form of chronic dizziness, has led to the development of an exercise-based rehabilitation programme. This has now been adopted by audiology and physiotherapy services across the UK. It has been commercialised in the form of a DVD for home use and is now being promoted and adopted internationally.

Our second, from the DCC, highlights the translation of research in bioanalytical methodology to the detection of prohibited substances by athletes. The major impact of this ongoing work was the delivery of the anti-doping analysis at the London 2012 Olympic and Paralympic Games. This operation was unprecedented with regard to speed and accuracy and succeeded in protecting athletes' health and integrity of the Games. Further impact is the help that the anti-doping facilities used for London 2012 at Harlow (GSK) gave to the development of a world-class resource to help revolutionise healthcare in the formation of The MRC-NIHR "Phenome Centre", now based at the Hammersmith Hospital.