**Institution:** Imperial College London

**Unit of Assessment:** 04 Psychology, Psychiatry and Neuroscience

## a. Context

Founded in 1907, the College is the first UK university to have the application of our work to industry, commerce and healthcare as central to our mission. Here we describe how we have enabled this mission to be addressed by the three vibrant research groupings within UoA4 (Neuroinflammation and Neurodegeneration, Brain Plasticity and Recovery, Neuropsychopharmacology and Mental Health). We also outline our plans to achieve even greater impact in coming years. Our translational strategy starts with the engagement of major stakeholders:

i) **With doctors and patients** for health and welfare impact through:

- Improved diagnostics and definition of disease, e.g., development of the FLAIR MRI sequence now used routinely on clinical brain imaging scanners (Brain Plasticity and Recovery); development of nuclear medicine markers for early neurodegenerative diseases (Neuroinflammation and Neurodegeneration)
- Improved health outcomes, e.g., development of novel therapies such as hypothermia for neonatal hypoxic-ischaemic injury (Brain Plasticity and Recovery); management guidelines to improve prognosis for Duchenne muscular dystrophy (Neuroinflammation and Neurodegeneration)

ii) **With the Health Service** for an impact on healthcare delivery and cost effectiveness, through:

- Improved delivery, e.g., development of screening measures for risks of alcohol abuse in patients presenting in A&E (the Paddington Alcohol Test; Neuropsychopharmacology and Mental Health); defining best use of deep brain stimulation for treatment of tremor, dystonia and Parkinson's disease (Neuroinflammation and Neurodegeneration)
- Service evaluations, e.g., outcome measures for child and adolescent mental health service delivery (Neuropsychopharmacology and Mental Health)

iii) **With business leaders** for impact on commerce and the knowledge-based economy, through:

- Partnerships for creation of "spin out" companies, e.g., Imanova
- Knowledge transfer, e.g., for experimental medicine in early stage drug development (Brain Plasticity and Recovery); sustained industry investment in research and development through advisory roles (e.g., in GE Healthcare [Brooks]); influencing business strategy through joint appointments to senior industry roles (e.g., GlaxoSmithKline [Matthews]) and honorary appointments for senior industry scientists (e.g., Richardson, Rubio, [GSK], and Kolb [Lilly]).

Furthermore we consider engagement with the wider public (e.g., debate about regulation or licensing of treatments, recreational drugs or devices affecting the brain [Neuropsychopharmacology and Mental Health]), governmental and professional societies to shape policies, regulations and professional guidelines (section b) as integral to extending the reach of our work and form the basis for future impact. All of these areas have been integral to our approach to impact to date and shape our plans during the next REF period.

## b. Approach to impact

At the heart of our long-standing approach to impact is a commitment to reducing the burden of ill health. We deploy a range of coordinated mechanisms for engagement with all our beneficiaries to enable unit staff to achieve significant health and wealth impact from their research.

**Framework for Creating and Extending the Reach of Impact on Healthcare Beneficiaries:** Research within the unit takes place in the context of the Imperial Academic Health Science Centre (AHSC), which aligns strategy and investment in research with Imperial College Health Care NHS Trust (ICHNT). Over this assessment period, we have co-localised all laboratory based neurosciences in 2500m$^2$ of the purpose-built Burlington Danes building on the Hammersmith Hospital Campus. The ability to showcase a full range of activities from basic discovery through clinical neuroscience at a single site has facilitated greater public and charity engagement, e.g., through annual 'Meet the Scientist' events where patients, their families and charity representatives speak directly with our researchers. It has helped us to develop greater industry involvement e.g., Imanova, a public-private partnership (also in the Burlington Danes building) that is addressing both industry needs for drug development and academic led discovery. We derive substantial

synergy for innovation intended to facilitate clinical and economic impact through interactions with the wider College In a specific example, within our College-wide Neurotechnology Initiative (which fosters collaborative research at the interface of neuroscience, engineering and physical sciences), the Brain Plasticity and Recovery group are working jointly with the Bioengineering Department to development new biomechanical approaches for reducing brain injury, and with Chemistry for novel therapeutic molecule candidate generation to enhance neuroregeneration after spinal cord injury. Adjacent to the Burlington Danes Building is our flagship c£70M facility Imperial Centre for Translational and Experimental Medicine which includes the NIHR/Wellcome Trust Clinical Research Facility which supports our clinical researchers for the early (Phase I/IIa) evaluation of novel interventions. Our researchers additionally benefit from the Imperial Clinical Trials Unit which offers academic services for study design, monitoring and management across all trial phases.

To encourage rapid translation of our research into the clinic, we have embedded research units in hospitals, e.g. for comprehensive research and clinical service provision in movement and balance (Bronstein), neuropathic pain (Anand), stroke (Geraghty, Veltkamp), the autonomic nervous system, mental health (Barnes, Crawford, Tyrer), the National Gambling Centre (Lingford-Hughes), the National Psychopharmacology and Club Drug Clinics (Nutt). The close alignment of the West London Mental Health Trust strategy with that of the College through the jointly appointed Director (Ritchie [UoA2]) has enabled important developments such as the PREVENT early cognitive impairment intervention cohort, which promises a novel “trial ready” population for early phase clinical trials. We have engaged closely with the AHSC embedded Trusts through joint clinical or honorary clinical cross appointments, e.g., in stroke (Veltkamp, Geraghty), in mental health (e.g., Crawford, Ritchie, Tyrer).

Our NIHR Imperial Biomedical Research Centre (BRC, £113M [2012-2017]) provides a core infrastructure and technical platforms in genetics/genomics, stratified medicine, biobanking and imaging. We anticipate that recent work (e.g., the first UK trial of stem cell therapy for stroke [Bentley], Phase IIa study of Deferiprone as a disease modifying treatment for Parkinson’s Disease [Dexter], development of electronic aids for age-related visual impairments [Cheong-Lee], an innovative trial of incretin therapy for Alzheimer’s disease [Edison]) will form the basis of future impact. We are extending our impact reach by acting as an academic partner with local provider trusts in the NIHR Collaboration for Leadership in Applied Health Research and Care (CLAHRC, renewed 2013-8) which facilitates dissemination of new therapeutic approaches. The AHSC reach was extended in 2012 when it became nested within Imperial College Health Partners (ICHP), a limited company formally integrating the College with both the 10 local acute care and the 2 mental health trusts. NHS England has designated ICHP as an Academic Health Science Network (AHSN, 2013) and host of the NIHR Local Clinical Research Network (LCRN, 2014-2019, £75M).

**Impact on Commerce and the Development of a Knowledge-based Economy:** To foster knowledge transfer with industry we have made joint appointments (e.g., GSK [Matthews], Imanova [Gunn], GE Healthcare [Brooks, until 2011]) and engaged industry scientists on honorary appointments (e.g., Merck [Hill, retired], Lilly/Avid [Kolb], GSK [Hind, Rubio, Zvartau-Hind]). In 2011-2012, we undertook 54 consulting projects for 30 distinct commercial clients, including GSK, Pfizer, Johnson & Johnson, Novartis, Astellas, Grunenthal Germany, and Spinifex Australia.

To promote a knowledge-based economy and to exploit research discovery, the College, through Imperial Innovations plc supports academic staff to create, build and invest in pioneering technologies, combining the activities of technology transfer, company incubation and investment. Since 2005, Imperial Innovations has raised over £200M from investors for such ventures, outcomes of which are tracked closely. Imperial Innovations provide sessions for academics, at all stages of their careers, to discuss tentative ideas for exploitation. We have re-launched its subsidiary NIHR Imperial BRC/Innovations ‘primer’ fund as the Imperial Confidence in Concept (ICiC) scheme for 2013/14, this time enhanced with an additional award of £700,000 from the MRC, aligned funding from our Wellcome Trust Institutional Strategic Support Fund (ISSF) and matched Higher Education Innovation Fund and College support. ICiC currently supports 19 projects (£1.3M) of which a high proportion will form future impact cases. To monitor impact, the AHSC Research Committee regularly assesses industry engagement and new clinical trial activity and has sought direct industry feedback. The AHSC Joint Research Office provides a strong governance framework and enables contract negotiations for external interactions with industry.

**Policy, Regulatory and Professional Influence**: Our staff are encouraged to contribute their expertise to external government, healthcare and industry advisory groups to shape policy, funding and service provision. For example through NICE panels (including Schizophrenia Core Interventions [Barnes]; Borderline Personality Disorder [Crawford, Tyrer]; Psychosis with Coexisting Substance Misuse [Crawford]; Service User Experience [Crawford {Co-chair}]; Alcohol Abuse Treatments [Lingford-Hughes]); and other advisory bodies such as the Department of Health Dementia Antipsychotics working group (Barnes); UK Ministerial Advisory Group on Mental Health (Crawford); Korean Health Industries Development Institute London Health Forum (Matthews [Vice President]); US Critical Path Institute Multiple Sclerosis Outcomes Assessment Consortium (Matthews [Steering Committee]); World Health Organisation International Psychopharmacology Nomenclature Revision Group (Nutt); the Independent Scientific Committee on Drugs (Nutt [Chair]); the Working Group for Revision of Classification of Personality Disorders (Tyrer [Chair]) ;or leadership of professional or public organisations (e.g., British Neuroscience Association [Nutt {President 2011-13}], Royal College of Medicine [Bronstein {President 2013-}].

**Influencing Society:** We actively encourage engagement and dissemination of our research to patients and the general public with the aim of increasing awareness and generating public debate. We achieve this through public events, lectures, fora, exhibitions, reporting in the mass media, and the use of new and social media. In doing so, we work closely with the College's and local Healthcare Trusts Communications and make Wellcome Trust ISSF funding available to support engagement activities. Senior members of Brain Sciences are regular contributors to public scientific debate through multiple major media outlets (e.g., Radio 4, BBC television news, World Service, newspaper and web-based). Nutt has produced a book on drugs policy for the general public and made a series of radio and television programs on his group's research including the recent Channel 4 "Drugs Live", the most downloaded program in the history of Channel 4. Service users and the public at large are kept informed of research work and encouraged to become involved through channels that include: patient representation on Planning Boards and Management Steering Committees, (e.g., for the development of the OPTIMISE stratified medicine programme in multiple sclerosis); patient Information Leaflets (e.g., for engagement for MS or Parkinson's Disease tissue banking); dedicated websites, (e.g., presenting the Division's research to the public on its website or through the NIHR Imperial BRC); public presentations and workshops, e.g. the annual BRC Research Festival aimed at patients, their relatives and carers, the annual Imperial Festival and Fringe events (Wellcome Trust ISSF funded); bespoke engagement programmes (e.g., the Annual Meet the Scientist event [2012 event reported in the Telegraph]; "Pint of Science", our initiative which brings neuroscience talks to pubs across London; external events (e.g., Natural History Museum – Science Uncovered annual event,). *Reynolds* and other members of his MS Tissue Bank staff have made more than 40 public presentations of their work alone over recent years. BRC funding has been used to establish the Imperial Patient Experience Research Centre (PERC), to provide our researchers with advice, support and training to achieve higher-quality Public and Patient Involvement and Engagement.

**c. Strategy and plans:**

During the next REF period we will support and enable impact from current and future research endeavours. To achieve this, we will:

- **Promote our growing pipeline of devices, diagnostics and new chemical entities:** We will align elements of our devolved funding streams from MRC (ICiC), EPSRC (Impact Acceleration Award) and Wellcome Trust (ISSF) to create the Imperial Joint Translation Fund to create a £5M annual pump priming fund.
- **Develop further our close relationship with healthcare providers to improve service delivery and outcomes:** We will expand embedded clinical research units with development of an Acute Brain Injury research and a new Stroke Clinical Research Unit at St Mary's Hospital. The Imperial dementia cohort PREVENT will expand and be incorporated into the UK Dementia Platform (Matthews, co-PI) to improve both academic and industry access to our patient base for impact on therapy and management. Neuroscience is being developed as integrated Centre of Excellence within the AHSC. We will expand our health services research base in conjunction with ICHP and Imperial Business School to facilitate the assessment of cost effectiveness of our innovations for health care.

- **Expand the reach of our impact on healthcare beneficiaries** through our new Lee Kong Chian Medical School (LKC), a partnership between Imperial and Nanyang Technological University, Singapore. Neurosciences at LKC will be integrated with the unit through honorary appointments and research strategy intended to address common priorities (cognitive impairment with aging and reducing long term sequalae of traumatic brain injury) for healthcare and economic impact in both countries.
- **Further develop our infrastructure to increase the potential impact from our translational research:** Central to this will be renewal of our AHSC, NIHR Imperial BRC and BRUs, CLAHRC and AHSN funding to facilitate early translation of our discovery research through to dissemination and uptake. We also are partnering with Computing Sciences to adapt the eTRIKS data management platform to support large scale clinical research studies and will benefit from College investment in a Big Data Centre (developed jointly with Huawei).
- **Increase our impact on commerce, and development of a knowledge-based economy:** We will capitalise on UKRPIF-funded new building and facilities opportunities at the Imperial West development in West London to join in building our Research and Translation Hub (bringing engineering and physical sciences alongside clinical medicine at the Hammersmith site) and new bio-incubator space. We will exploit a £40M Joint Innovation Fund (supported by the European Investment Bank) developed through collaboration between the Technology Transfer Offices at UCL, Oxford, Cambridge, and Imperial Innovations to support University spin-out companies and also support the commercialisation of research opportunities in partnership with industry, retaining University ownership and reducing risk (spin-in). We will encourage further industry/academic knowledge exchange through increasing secondments (via Wellcome Trust ISSF support) and strategic alliances, and enhance our training programmes in conjunction with Imperial Innovations regarding exploitation, IP management and start-up formation.
- **Expand our impact on society.** We will work with ICHP to align Public and Patient Involvement and Engagement activities of the AHSC, AHSN, CLARHC, and LCRN, across tertiary to primary care settings. This aligned programme will be extended to local communities as part of the Imperial West development.

We will monitor the progress of these enabling activities through the College and AHSC Research Committees. Through the College Research Strategy office, the College has invested in Impact Officers to track the potential impact of research endeavours.

**d. Relationship to case studies**

Our approach to impact has emphasised close alignment between the unit and healthcare providers to foster an inquiring culture in which we learn from clinical practice. This has been a key factor in positioning our clinical investigators to lead in the development of clinical management guidelines and practice parameters for healthcare providers world-wide. The case **"Improving the assessment and treatment of personality disorders"** describes how we built on close patient engagement in specialist service delivery to develop improvements in the assessment for personality disorders. In the related case, **"Improved outcomes for Schizophrenia using evidence-based treatment"**, we describe the development of better medicine prescribing for both first-episode and established schizophrenia patients. Our approach to impact has emphasised the development of clinical research units embedded in hospital services. Within this our clinical investigators have developed novel therapeutic interventions out of specialist, academic led services. The case, **"Cooling babies limits brain injury"**, describes how we conducted fundamental animal studies to human phase III trials that established the benefits of hypothermia for salvaging injured brain during the critical early period following perinatal asphyxia.

We have had a long commitment to the development and application of advanced technologies to healthcare through developing close working relationships between technology developers and clinicians. A fundamental development that grew from such interdisciplinary work between radiologists and MRI physicists was the FLAIR MRI imaging sequence described in **"FLAIR MRI: transforming brain imaging for neurological disease**". FLAIR has been adopted as a standard radiological tool and is available on effectively all MRI scanners Our ability to develop solutions to hugely multidisciplinary problems with both commercial and healthcare impact, is illustrated by the case **"Improving neuroscience drug discovery through the application of human molecular imaging"**, which describes how sustained support at the technology/medicine interface has led to more confident decision-making for drug development and creation of a specialist service spin out.