Institution: University of Strathclyde

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

a. Context

Our aim is to improve health, life expectancy and quality of life for individuals using a translational agenda delivered through longstanding collaborations with non-academic partners. The immediate impact is on the pharmaceutical, biomedical technology, rehabilitation and public health sectors by generation of new products and more efficient processes and procedures. The main types of impact are better medicines and methods of drug delivery; changes to products, practice and policies affecting staff and patients in NHS and non-UK health providers; new technologies and applications for the pharmaceutical and biotechnology sectors; and new medical devices developed in collaboration with clinicians and industry to address existing and emerging clinical needs. The main beneficiaries are as follows:

Practitioners and policy makers in the National Health Service benefit from the impact of research by the following of our Research Groups: Medicines Use & Health, Pharmaceutical Sciences, Rehabilitation Engineering and Medical Devices & Diagnostics. Direct links between NHS staff, patients and our knowledge base are provided by staff in the Speech and Language Therapy Research Group and specialist prosthetic and orthotics referrals (for example Brachial Plexus Service Scotland). The Scottish Network for Rehabilitation Research provides a knowledge exchange (KE) forum for academic researchers in rehabilitation and allied health professionals across Scotland's NHS boards. NHS Greater Glasgow & Clyde (GG&C) uses bespoke clinical research facilities in Glasgow Royal Infirmary for motion analysis.

The pharmaceutical industry and biomedical technology and medical technology companies benefit from activities by the following Research Groups: Infection Immunity & Microbiology; Cardiovascular Research; Cell Biology; Neuroscience; Rehabilitation Engineering and Medical Devices & Diagnostics. The EPSRC Centre for Continuous Crystallisation & Manufacturing (CMAC) is a driver for research into pharmaceutical manufacturing processes.

Specific patient and community groups benefit from the outputs of the Rehabilitation Engineering; Medical Devices & Diagnostics; Cell & Tissue Engineering; Health & Nutrition; Speech & Language Therapy and Medicines Use & Health Research Groups.

Cancer Research UK (CRUK) benefits directly from research in the CRUK Formulation Unit, on drug formulation for commercial applications.

b. Approach to impact

Interaction with clinical and commercial parts of the health sector is an important activity. Staff engage with local, national and international clinical communities, research groups and industry across a range of areas. These interactions influence a significant portion of our research to make sure that it – and its outcomes and impacts – are relevant and meet clear clinical, social and/or commercial needs. Between January 2008 and July 2013 we used multiple mechanisms for generating impact.

University mechanisms to support development of impact

(i) **Research & Knowledge Exchange Services** (RKES) provides professional services to optimise impact, including identifying and protecting University intellectual property, supporting funding applications, and developing engagement with businesses, organisations and strategic partners. Underpinning our case studies are researchers' engagement with RKES and the process of new invention, disclosure, commercialisation planning, marketing and business development activities. Working with researchers, RKES identifies the most appropriate route to market – licence, start-up or spin-out – and secures the necessary approval and funding. Strathclyde was fifth in the UK in terms of companies formed in the last decade and remains in the all-time UK top 10 for licence royalty. Examples of successful commercialisation activity within UoA3 during the current REF period include spin-out company formation (OhmMedics, Rathlin Medical, Fixed Phage, Solus Scientific, Biogelx Ltd); licensing (HemoSep); and start-up (MGB BioPharma) activities.

(ii) **Funds to facilitate impact:** the **Knowledge Exchange Development Fund** (KEDF) supports pump priming of KE between the University and external organisations in all sectors. In particular, KE activities requiring start-up funding that can forecast a return on investment and future income generation are encouraged. Departmental agencies (KE Hub, Strathclyde Institute for Medical

Devices, Strathclyde Med Tech – see below) and the KEDF make funds available for Scottish SMEs. Examples include a partnership with Philips to optimise the delivery of "Inhalosomes" with a Philips nebuliser. The **Knowledge Transfer Account** (KTA) used EPSRC funding of £2.6M (2009 – 2012) to help industry take advantage of our research, technology and consultancy. An example is the development of a confocal mesoscope, in partnership with Mesolens Ltd. The KTA investment has accelerated and enhanced Strathclyde's strong links with industry through activities including partnership research programmes, secondments and Proof of Concept development. As a result of the success of the KTA, EPSRC awarded £1.86M in 2012 to support development of impact from our EPSRC-funded research portfolio. The resulting Strathclyde **Impact Acceleration Account** (IAA) runs for 3 years from 2012. The IAA will accelerate impact from Strathclyde's EPSRC-funded portfolio for economic and social benefit. Examples within UoA 3 include the application of imaging technologies to improve the *in vitro* fertilisation process, in partnership with the Glasgow Centre for Reproductive Medicine and the appointment of an artist in residence at CMAC to accelerate impact and outreach with the general public. The **Strathclyde Entrepreneurial Network** uses Strathclyde 100, a network of alumni entrepreneurs and industry experts involved in mentoring, advising and supporting the next generation of entrepreneurs from Strathclyde's student, alumni and academic communities. Researchers present business ideas at quarterly events and can be paired with a Strathclyde 100 Enterprise Partner. Researchers working on Strathclyde-initiated projects - Inhalosomes, Solus Scientific Solutions, ECMO life support system (now Rathlin Medical Ltd,) and WoundSense (now Ohmedics Ltd) used this network.

Activities within UoA3 that support development of impact

(i) **The SIPBS Knowledge Exchange Hub** (KE Hub) was established in 2010 with ERDF funding of £1.17M. It fosters links between academics and Scottish SMEs and has done so successfully for over 20 companies and a further 20 networks, generating £2.3M of additional funding for these collaborations and implementing a process to capture future impact. A key initiative of the KE Hub was to mentor a pool of postgraduate and postdoctoral "project champions" to manage and commercialise projects while receiving entrepreneurial training. Over 40 project champions have been recruited since 2010. Success and impact generation via this is exemplified by the formation of Inhalosome-C Ltd. The **Strathclyde Institute for Medical Devices** (SIMD) and the ERDF funded **Strathclyde Med Tech** (SMT) facilitate interactions between academia and clinical, and commercial sectors. These – and the relationships established through them – enable academics to identify new research and KE ideas and to progress them with partners from pump-priming to fully funded programmes. An example of impact generation through this is Brightwake Ltd. Initial interaction with this company involved a TSB-funded joint research project that led to development of the HemoSep blood recovery technology. The University has continued to engage with Brightwake through a successful KTA project and an FP7 application involving Strathclyde with 11 non-academic partners across Europe (4 commercial, 7 clinical). This growth of engagement between Brightwake and the Medical Devices & Diagnostics Research Group, facilitated by SIMD, is typical of the acceleration of engagement across the medical devices development portfolio.

(ii) **Appointment of staff who hold both academic and NHS posts** (including Bennie, Akram and Thompson) is a further route to impact. Joint-appointment staff are able to apply their research directly to issues of guidelines and palliative care practice within the NHS. We also offer Honorary appointments to international figures from clinical centres and the pharmaceutical, medical technologies and life science industries.

(iii) **The Doctoral Training Centre (DTC) in Medical Devices** provides staff across Faculties with access to DTC studentships; it fosters multidisciplinary academic interaction and projects must have both clinical and commercial input. Similarly, Strathclyde has a postgraduate programme with GSK that promotes academia–industry interaction and staff development in the Company.

(iv) **External facing Centres:** the **CRUK Formulation Unit's** research has led to significant advances in the formulation of medicines to treat cancers, evidenced by global sales of temozolamide and abiraterone. The **EPSRC Centre for Innovative Manufacturing – CMAC**, established in 2011 to generate quicker, more effective and sustainable methods of medicines manufacture, has a focus on the development of continuous manufacturing and processing to replace batch production. CMAC is a key part of the Technology and Innovation Centre (TIC) where academics and industry staff are starting to work collaboratively on projects of mutual

interest and benefit (see below). The **Industrial Biotechnology Innovation Centre** (approved, November 2013) will add to our external facing capacity; it is an academia / industry collaboration led by Strathclyde and funded by the SFC. It will focus on product development and improving manufacturing processes to enhance the Scottish bioeconomy.

External mechanisms of support

(i) **Scottish Enterprise** has a Proof of Concept Programme (PoC) to support pre-commercialisation of technologies from Scotland's universities. Strathclyde has 10 PoC projects in drug discovery and drug delivery, one of which led to the formation of spin-out company XstalBio (UoA8) prior to the REF period and four of which underpin submitted case studies in UoA3. Scottish Enterprise PoC funding underpinned the spin-out companies OhmMedics Ltd and Rathlin Medical Ltd and the start-up company MGB BioPharma Ltd.

(ii) **Knowledge Transfer Partnerships** (KTP) help businesses improve their competitiveness and productivity through better use of the knowledge, technology and skills in the UK. Strathclyde is 1st in Scotland and 4th in the UK for KTP activity and ambitious to improve; there are currently 2 KTP projects in SIPBS – our researchers support Bio-Images Research to establish a new drug delivery division with opportunities for high business growth and we work with NHS GG&C to validate the quality, efficacy and safety of unlicensed medicines supplied within NHS patient care.

Public Engagement

We provide support to schools in biological sciences, drug discovery and biomedical engineering and have participated in a number of high profile events. For example, Roberts presented a public lecture on *Microbes in Contact Lenses* at the British Science Festival (Aberdeen) and Millington co-organised a musical immunology performance at the Centre for Contemporary Arts in Glasgow and *Going Viral,* a public art exhibition of 3-D images inspired by the immune system, shown in Glasgow and London. Dufes presented her research to HRH The Princess Royal and senior school pupils at the first Medical Research Scotland *Meet the Researcher* showcase. UoA3 staff participate in the annual week long Scottish Space School@Strathclyde, providing school children with an appreciation of the health challenges of long duration space travel and living in low gravity environments. The annual University Research Day also engages school students. Researchers worked with more than 300 pupils from 9 primary and 3 secondary schools in East Renfrewshire and Glasgow on projects including: sanitation in developing countries; biomechanics, the science of human movement; the science of jelly; and young people's views on life in the digital age. Strathclyde is hosting the Children's University Scotland, the first project to be funded by a charitable foundation established by Scottish Power. The programme enables young people to make the most of their abilities and interests, regardless of their background and hopes to positively influence future life choices. UoA3 staff will be contributing to this initiative.

For broader public engagement: P Rowe contributed his stroke research work (Envisage) to a Parliamentary Reception highlighting RCUK multidisciplinary research projects; Hoskisson was an expert guest on Radio 4's Naked Scientists discussing antibiotics; and many staff have been interviewed by the media to comment on projects and breaking news. Staff contributed via the advisory panel and through donations of exhibits to the Wellcome Trust-funded *Bodyworks* exhibition at the Glasgow Science Centre – staff from the Medical Devices & Diagnostics Research Group showed several exhibits highlighting the impact of medical technologies in rehabilitation and independent living. As a particularly innovative approach, Plevin created *The Angina Monologues* using drama to present the science behind obesity and cardiovascular disease. It received wide press coverage (Times Education Supplement, Glasgow Herald, The Sun, BBC) and was shortlisted for the community project of the year award in 2009.

Staff in the Cell & Tissue Engineering Research Group play an active role in the safety of medical devices. This has contributed to the identification of implant toxicity in the orthopaedic device sector, withdrawal of one of the most commonly implanted hip replacements from the marketplace, and production of new guidelines. UoA3 Staff in the National Centre for Prosthetics & Orthotics, bring affordable technologies to low-income countries, working with charitable organisations to provide support and improvement in provision of prosthetic devices. Projects based in the Gambia and India are active – for example, the Mukti Mobility Project, is part of the University's global humanitarian campaign that aims to achieve change through permanent improvement in delivery of prosthetic and orthotic services provided by the charitable MUKTI organisation (Chennai, India).

Staff development

The annual Accountability & Development Review constitutes a staff member / line manager meeting. It focuses on (*inter alia*) research and KE allowing staff to reflect on their achievements in the past year and develop plans for the coming year. Promotion processes can reflect KE success, and KE Professional is a job family introduced for staff whose primary focus is KE. The importance of generating impact from research is well understood by staff in UoA3, many of whom have benefited from University organised workshops on various aspects of KE, external engagement and commercialisation.

c. Strategy and plans

We plan to increase research collaborations – within the University and with industry – to intensify transfer of our research into commercial products and services. We have ambitious targets in generating Impact, and will make significant contributions to help achieve the University's Outcome Agreement with the Scottish Funding Council: doubling the value of consultancy and continuing professional development income over 5 years; securing Strathclyde's position in the UK Top 3 for KTP involvement; increasing licensing agreements from 20 (£0.5M) to 40 (£2M) in 5 years and accessing the University's new investment fund with its focus on Health to create more high-prospect spin-outs.

A major strategic driver over the next 5-year period is the Technology Innovation Centre (TIC), which as mentioned earlier brings academia and industry together to work on problems of mutual benefit. A new building (£90M) will be completed in 2014 to enable us to capitalise on the University's strong relationships with business and industry – the building is a tangible element of TIC but the underlying philosophy of collaboration outside academia crosses the University. CMAC is a key part of this strategy – researchers won an £11M Research Partnership Infrastructure grant, matched by £22M from industry that will equip CMAC laboratories in the TIC. As part of the TIC strategy, *Health Technologies at Strathclyde* (HTaS) has been created to facilitate interactions between the University, NHS and industry. A Director has been appointed and International Advisory Panel created (chaired by the ex-CEO of Roche Pharmaceuticals). Several members of this advisory panel participated in a *Confidence in Concept* workshop as part of an MRC Biomedical Catalyst award (£300K; 2012).

Growth in postgraduate student population: building on experience with the EPSRC Centre for Doctoral Training in Medical Devices we will develop centres based on emergent technologies – for example using laser-driven radiation sources for therapeutic interventions in oncology.

d. Relationship to case studies

The case studies illustrate the different mechanisms by which impact is generated and the variety of vehicles used to achieve economic, healthcare and quality of life benefits.
The "D*evelopment of the spin-out company Ohmedics Ltd."* derived from research on non-invasive wound diagnostics in the DTC in Medical Devices, with input from the local clinical community.
The case studies on "A*utomated assays for rapid mass screening and detection of bacteria and toxins"* and "A*doption of an innovative non-invasive delivery method for drugs and vaccines"* used support from Strathclyde's RKES and external agencies (Scottish Enterprise and TSB) to develop the technologies and establish companies.
The CRUK related case study on "*Improved health and survival rates for patients with malignant brain and prostate cancers"* exemplifies the use of specialised units to generate research that leads to commercially viable drug formulations.
The benefits of having joint appointments with the NHS are illustrated by two case studies on "*Improved patient care through new guidelines for antibiotic dosing and monitoring"* and "*Improving palliative care through better engagement of community pharmacies"*.
The importance of working with a commercial development partner (identified through Strathclyde Institute of Medical Devices) to develop technology to allow beneficial application in patient care is indicated by the case study on the "*HemoSep auto-transfusion system to reduce blood transfusions and related complications during open-heart surgery*".
Finally, the "*Evaluation of the biological safety of metal-on-metal hip resurfacing implants*" is indicative of the benefits that can arise through collaborative relationships between industry, clinicians and academics, and is typical of the unit's approach to engagement with interested clinical and commercial parties, a key part of our impact strategy.