Institution: University of Aberdeen

Unit of Assessment: 8 (Chemistry)

a. Context

Within our Unit, we derive economic impact, influence on policy and legislation, and create impact with practitioners and services via successful transfer of academic research findings and new knowledge. Our activities include fundamental and applied research, and near to market activities, as illustrated by examples in this document. For each of the different stages within a research cycle, we engage with appropriate funding bodies, end-user partners and other non-academic stakeholders.

We maximise our impact and sphere of influence by interfacing efficiently with other disciplines across the University, in addition to partnerships with other academic institutions and industrial partners, where we make significant contributions to the chemical sciences industry. We interact and provide support to companies via knowledge exchange, development of new technologies, and through basic underpinning research. These contributions occur across the spectrum of the chemicals sector. Current and recent examples including upstream oil and gas (MI Swaco, MI Drilling Fluids, Scotoil), petrochemicals (SABIC, UOP, Ingen GLT), fuel additives (Innospec), pharmaceuticals (Shasun Pharma, Johnson & Johnson, Schering Plough, Servier, Aquapharm), agrochemicals (Becker Underwood), catalyst manufacture (Johnson Matthey), nuclear waste processing (Nuclear Decommissioning Authority), and energy technologies (Sasol).

Our success with commercialising the results of research has also increased since 2008 through licensing out technology and by the creation of two additional spin-out companies. Given the nature of the research performed by the research groups, maximising reach and significance often involves developing an idea or series of ideas at a relatively fundamental level and then extending these, either institutionally or in direct partnership with industry.

Our activities, in particular those associated with speciation of toxic compounds, also lead to interactions with regulatory bodies in the field of policy development, such as the Food Standards Agency (FSA) and their equivalents around the globe (FAO/WHO Food Standards program, European Food Safety Authority, Chinese Import Regulations).

b. Approach to impact

Activities which underpin the generation of impact principally relate to technology development and knowledge transfer. Where our knowledge and research base is deemed to be appropriate to a specific industrial issue, or is sufficiently close to market, we establish fully-funded industrial collaboration grants (e.g. SABIC, Saint Gobain, ScotOil). However, in the main, our approach is to partner with industry to utilise our research knowledge and grant schemes where third party funding is required. This is done by our staff both through direct approaches to industry and by responding to industry contacts resulting from promotion of our research expertise. For example, a successful mechanism has been the EPSRC CASE scheme through which we currently have 4 CASE funded studentships (Johnson Matthey (x 2) and NDA (x2)). A CTA and a PhD CASE award in the area of biomaterials resulted in three patent applications which were licensed to Apatech Ltd. Additionally, a TSB/EPSRC grant (REGENBONE) with Apatech Ltd (initially with B1 Medical) was based on establishing the feasibility of a scaffold-cell combined product for bone regeneration (£590k). A TSB/BBSRC synthetic biology grant with Ingenza (an Edinburgh based company) and the University of St Andrews (£500k) was initiated by a patent application filed by the Universities of Aberdeen and St Andrews.

We also use available knowledge transfer schemes. Through Knowledge Transfer Partnerships (KTP) we have undertaken research to improve ink distribution on medical test strips with Lifescan (**Anderson**/Chandler - Engineering), and in agrochemicals with Becker Underwood **(Jaspars**). Similarly, we engage widely with companies through our knowledge transfer grants (7 KTG awards during the period) involving research into the understanding of modes of operation of fuel additives (Innospec); development of biomaterials (Apatech); novel routes to manufacture of biodegradable chelants for detergent action (Innospec); understanding of scale inhibitors (MI Swaco); catalyst development for hydrogen from methane (UOP); and CO-tolerant Photoanode for low temperature fuel cells for transport and energy generation. Additionally, the Scottish Funding Council SPIRIT scheme has been used to foster interactions between the university and SME's leading to 2 awards, one for improved catalysts for synthetic routes to pharmaceuticals (Shasun),

and the other for understanding of scale inhibitor action (MI Swaco). We also engage with SME's through schemes such as Kick-Start, where we have worked with local companies (e.g. Ingen GLT).

Regarding the commercialisation of research, we have strengthened the activity of one of the Unit's spin-out companies since 2008, and two further spin-out companies have been established. This commercialisation success is reflected in the high ranking (6th in the UK) position of the University of Aberdeen in terms of successful spin out companies over the period 2010-2012 (Praxisunico spinouts UK survey, report 2013).

a) Tau Rx activities (**Storey**) have developed since 2008 with 7 international patents and development of the drug, Rember.TM which has been used in a successful phase II clinical trial indicating a possible important reduction in the rate of progression of Alzheimer's disease. Phase III trials are in progress (Case Study 3).
b) Enocell was created following an initial Proof of Concept (PoC) award which followed a joint industry-academic study on photoelectrocatalysis for water purification (**Macphee**). The commercial strategy developed during the PoC enabled the spin-out of Enocell Ltd from the University in 2011. Enocell Ltd has since been awarded a SMART grant (£70k) to demonstrate the transferability of the technology concept to a direct methanol fuel cell (DMFC) configuration, since successfully completed (2012). From this technology platform, Enocell, together with its network partners, aims to provide, at accessible cost to the consumer, durable fuel cell-based energy systems for use by local communities in developing world markets to generate power.
c) SIRAKOSS was created following research in biomaterials initially funded through a KTG award followed by a PoC grant (2007-09 **Gibson/Skakle**). This was followed by a PoC extension (2009-10) then a SMART grant (£70k) to the spin out company, SIRAKOSS (2011). The activity is based upon 3 patents derived during the PoC grants (**Gibson/Skakle**). The technology being commercialised by SIRAKOSS will lead to bone grafts that help patients heal faster and reduce pain associated with current gold standard treatment.

We also strive to influence industry policy and professional practice, to contribute to debate and understanding of key environmental issues, and to broaden the impact of our research in the public domain, where we have worked with the Food Standards Agency. This includes, for example, research related to food contamination (e.g. As levels in rice, Case Study 1).

At an individual project level, we seek to disseminate our research findings as widely as possible. Researchers regularly engage with the media. For instance, as part of *PharmaSea* (an EU FP7 project) there was an extremely successful media release in early 2013 which led to a total of 42 million unique visitors to the University web pages. The research findings were also disseminated via a BBC Radio 5 Interview, a Radio New Zealand interview, coverage in specialist magazines (Chemistry World, RSC News, European Biotechnology News), through on-line coverage, most significantly BBC News (with 29 million unique visitors to the health pages), and a further 4 million unique visitors to the World News USA pages). Staff participated in the British Science Festival (held in Aberdeen 2012), and the Cheltenham Science Festival, and a number of staff members have given demonstration lectures in secondary schools around Scotland as part of our outreach activities. As an unusual example, the Marine Biodiscovery Centre partnered with the Scottish Area Flower Arranging Societies to create an exhibit at the Royal Horticultural Society's Chelsea Flower Show 2013, showing the importance of coral reefs in the discovery of new medicines. The display was highly praised for its educational message and received a gold medal from the Royal Horticultural Society. Additionally, working together with a US toymaker Tangle Creations, a set of models to help teach protein chemistry ('Tangleproteins') was developed and is now available commercially as a kit.

External engagement is supported at an institutional level by the Public Engagement in Research Unit (PERU) and the Researcher Development Unit (RDU) which support the dissemination of research findings, development of impact, and provide training to PhD students, postdoctoral fellows and academic staff on dissemination and public engagement. The University is one of only 7 successful UK institutions (and sole Scottish HEI) to obtain an RCUK Catalyst award to support institutional culture change around public engagement with research. Researchers involved in these activities are offered reduced workloads in other areas to encourage participation. We have a comprehensive programme of engagement opportunities designed to overcome the barriers between skills acquisition and delivery through interactions with the RDU.

The University has signed the Public Engagement Manifesto 2012, and through this endorses the principles of the Concordat for Engaging the Public with Research 2010. The University's Research & Innovation office provides staff with advice and support in all interactions with industry.

c. Strategy and plans

Our strategy towards building impact for the future is centred on our three research groups, Energy and Environment, Materials Chemistry and Biomolecular Chemistry. In Energy and Environment, our strategy involves firstly building on industry links established with the oil and gas industry through, for example, the MSc (Oil and Gas Chemistry) program and its' industrial steering group, and positions on the oil & gas UK Continental Shelf (UKCS) technology strategy steering group. By embracing opportunities created through the university-wide Energy theme, the Energy and Environment group will seek to further develop interactions will the oil and gas sector, exploiting the current buoyant state of this sector, and recruiting appropriate additional staff. Secondly, the impact of our research on the cement industry (case study 2) will be developed through an on-going "Green Concrete" project and through recruitment of further staff with research skills appropriate to this area. This exploits our strong reputation with the industry, and produces a productive overlap between Energy and Environment and Materials Chemistry. Other areas of overlap between Energy and Environment and Materials Chemistry which will be developed for impact within the oil and gas sector are the development of polymers tolerant to high temperature, high pressure conditions (**Imrie)** and corrosion inhibition (**Cuesta**).

The Materials Chemistry group will expand its impact beyond biomaterials, by seeking opportunities to extend the successful fundamental research in electronic and magnetic materials (EPSRC grants to **Skakle** and **Mclaughlin** (2)) through industrial links. In particular, KTN networks will be exploited to establish connections with companies such as IBM, Hitachi and Seagate using spintronics for data storage.

In Biomolecular Chemistry, the Marine Biodiscovery Centre will continue to develop the importance of marine and industrial biotechnology via platforms such as membership of the Bioscience KTN Industrial Biotechnology Steering Group, and the IUPAC Subcommittee on Biotechnology. Tau Rx will remain a focus of biomedical activity. Opportunities to offer facilities and interface with other organisations will increase following the establishment of a new GMP laboratory, contributing to a unique combination of CGMP, GCP and GLP accredited facilities in a Chemistry Department. Additionally, the analytical group within Biomolecular Chemistry is part of a proficiency testing scheme within the food sector (FAPAS). Our satisfactory performance in the scheme has qualified us to carry out contracted analytical work for government organisations such as the Food Standard Agency (see references in Case Study 1) and clinical trials for the pharmaceutical industry (recent funding from Aptalis, **Krupp**, ~£450k).

d. Relationship to case studies

Three case-studies have been selected that offer exemplars of the Unit's approach to impact. The success of our strategy in defining research groups and maximising opportunities to work with other disciplines means each group is able to contribute a case study to this assessment. Two of the case studies involve collaboration with other units of assessment.

Case Study 1. This case study, regarding levels of arsenic in food, is a strong example of our engagement with UK and EU policy makers. It derived from the multi-disciplinary approach at the core of our research strategy. Impact was generated through a combination of engagement with regulatory bodies during the course of the research, and by other regulatory agencies discovering the outcomes of our research through public engagement activities. Close working of **Feldmann** and **Krupp** with the FSA and other regulatory bodies both in the UK and overseas remains at the heart of our impact strategy.

Case Study 2. This case study builds on our long history of research in cement chemistry. It relates to the use of limestone as a reactive supplement for Portland cement. The combination of thermodynamic modelling and experimental work has given the industry the ability to reduce its carbon dioxide emissions by an estimated 10%.

Case Study 3. Through collaborations with researchers in mental health we are deeply involved in the University spin out company TauRx Therapeutics, which is concerned with the design, development and clinical testing of drugs for the treatment of Alzheimer's disease (AD) and fronto-temporal dementia (FTD). Chemistry's impact has been through our successful scale up of the synthesis of drug candidates and our provision of accredited analytical facilities.