Institution: Cardiff University

Unit of Assessment: UoA5

a. Context: Biosciences at Cardiff has economic, environmental and medical impact across a spectrum of sub-disciplines including pathophysiology of disease, neuroscience, systems biology and molecular ecology. This is achieved through the implementation of our Innovation and Engagement (I&E) strategy by a dedicated Biosciences I&E Team (4 FTE) responsible for industrial partnership, engagement and employability. The team engages with a range of beneficiaries (e.g. government, charities and industry) to promote and maximise the impact of research from Biosciences' four sections. Strategic objectives are encompassed by two areas of activity:

Economic Impact: We are active in consultancy, product development, knowledge transfer and training to support SMEs and multinationals. Particularly relevant sectors are pharmaceuticals (e.g Merck and AZ); nutraceuticals (e.g. Seven Seas Plc, Obsidian Research Ltd.); consumer healthcare (e.g. GSK Consumer Healthcare); molecular diagnostics (e.g. GE Healthcare and Argutus Medical) and the water industry (e.g. Welsh Water and Modern Water Plc). We engage at multiple points within the innovation pipeline, translating knowledge to deliver products of marketable value. Partners have access to novel discoveries via licensing, knowledge exchange and investment opportunities. Intellectual Property (IP) is developed from concept to market by forming spinout companies, e.g. Nanotether Discovery Science Ltd. (NDS) with external investment of £2.1m in 2011.

Environmental and Medical Impact:
UK: Biosciences makes impact on policy locally and nationally on a number of fronts, e.g. Welsh Government's 'Science for Wales' and 'Wales innovation' strategies, the UK Government body 'Stem cells for safer medicines' and the 'UK National Environment Assessment' report. Awareness of research output is promoted to the general public via events (e.g. 'Cardiff Brain Games' and International Fascination of Plants Day) and media output (e.g. BBC1 and Discovery Channel nature programmes), interest groups (e.g. RSPB, Naturalist Society) and patient/carer groups, (e.g. Parkinsons UK, Arthritis Research UK, Cancer Research UK). Interactions with schools and sixth-form colleges enrich the curriculum in areas such as stem cells and brain awareness, ethical debate on animal experimentation, stem cell biology and threats to biodiversity, e.g. providing annual professional training courses in Genetics to 6th-form teachers and running a 'Bioscientists in schools programme'.

International: Our researchers impact on policy at EU and International levels, e.g. by assisting in the development of several EU FP7 calls, including those for the Health theme (e.g. 2013.2.2.1-4: pathophysiology and therapy of epilepsy; 2013.1.4-1: controlling differentiation and proliferation in human stem cells). Beyond the EU, we have developed habitat management plans in China and Malaysia, and we have influenced both eco-tourism and oil crop production in Malaysia.

b. Approach to impact: During the REF period, Biosciences has developed strategy, implemented by an I&E team who provide support to our research, teaching and student populations. They facilitate strategic interactions with non-academic users (including ca. 100 schools, 5 colleges, 50 industrial users, charities and interest groups). To engage users and to propulgate good practice we have established:

- An Editorial Board to produce a communication plan and manage media output
- A fortnightly "Bioconnect" seminar series to promote opportunities in maximising impact.

The team is responsible for benchmarking and monitoring research impact e.g. we entered the BBSRC "Excellence with Impact 2011" competition to seek external validation and feedback. Our engagement activities were highlighted as exemplars of best practice.

Economic Impact: Within the innovation pipeline researchers work with industry and the NHS to complete elements on the pathway from discovery to market. At the beginning of the pipeline we work with the University's Research Innovation & Enterprise Services to patent and licence novel discoveries. Interactions with non-academic users are generated from existing research contacts, strategic partnerships and networking activities. Interactions are supported via:

- RCUK funded industrial partnership awards and link grants (e.g. new diagnostics technologies and biological control of disease vectors, respectively)
- Technology Strategy Board and DTI (e.g. commercial research into stem cell therapies)
- Cancer Research UK and Arthritis Research UK who fund our cross-disciplinary centres
- Welsh Government "Academia for Business" scheme (e.g. Human tissue models for toxicity testing and molecular diagnostics).
- The NHS via joint academic/clinical appointments and providing access to facilities for anatomy and surgical training (e.g. the Wales Anatomy Centre)

We further interact within the innovation pipeline through funded partnership schemes including:

- 5 Knowledge Transfer Partnerships (value of £968,372), Biosciences is a University champion
- 3 Welsh Government & Industry Ser Cymru PhD awards (1st wave of a new programme)
- 7 3yr PhD and 7 1yr MRes Knowledge Economy Skills Studentships (KESS).

At EU level we facilitate consortium building activities that have led to 10 cooperation grants, 5 fellowships and 3 Training Networks. Our successes were supported by close working relationships between the partners (researchers and companies) and the dedicated administrative teams who undertake grant writing and provide legal and financial oversight. Researchers also foster project specific relationships with large industrial partners. Merck, for example, has invested >£12m over ten years in programmes developing novel cancer drugs initiated by the Dale laboratory. Other ongoing relationships developed into strategic partnerships driven by Bioscience include GSK Consumer Healthcare (2011), Welsh Water (2010) and GE Healthcare signed March 2012 in the presence of Edwina Hart, Welsh Government Minister for Business, Enterprise, Technology and Science.

Biosciences has a track record in forming spinout companies in the areas of eco-tourism, molecular diagnostics, stem cell therapeutics and water quality monitoring. We work with the University's technology transfer partner 'Fusion IP' in the spinout process. Since 2008 we have developed 1 public interest/not for profit company (Eco-explore) and 3 spinouts e.g. Nanotether Discovery Science Ltd, which attracted £2.1m of venture capital investment. All the spinouts developed have utilised funding from Fusion IP, Cardiff Partnership Fund and Finance Wales. Recognition of our innovation, translation and industrial collaboration is supported by awards such as the "BBSRC Commercial Innovator of the Year" for the Bioluminescence in Real-Time assay system (Murray, 2012); and NC3R's replacement Prize (Berube, 2012). We also incentivise innovation via our annual `Innovation Network` prize (Berube 2010 and Lloyd 2011).

Environmental and Medical Impact

UK: We engage with Government on numerous levels, with Ormerod influencing UK Government through development of environmental White Papers and Professors Ole Petersen and Sir Martin Evans contributing to policy development as members of the Welsh Government's Science Advisory Council for Wales. We have direct links with the Director of life-science sector team and Deputy Director for Health Innovation and recently provided feedback on the Welsh innovation strategy. The I&E team organises, supports and promotes public events to raise awareness of the biosciences such as National Science and Engineering Week, Brain Awareness Week, annual Neuroscience open afternoons and the Brain Bee competition (14-18 year olds). We work with the Community Engagement Team, Beacons for Wales, Career Wales, Techniquest Science Centre, the National Museum Cardiff and numerous individual schools. To support activities we have secured over £20K of external funding since 2008 from RCUK, the Royal Society and other sources. We continue to support engagement activities through McCann's and Jones' media roles (Discovery Channel, 1 series, BBC1, 3 series). Researchers have been recognised for the quality of their engagement by awards such as "Career Wales Most Valued Partner Award 2009", internal "Maximising Impact" awards, FameLab 2012 and two international documentary awards (The Washington Cine Golden Eagle Award and the Platinum Award at the Houston World Fest) for McCann's documentary, 'Lost in the Amazon'.

International: Biosciences works with the University EU office and Welsh Higher Education Brussels to develop links with the Directorate General for Research, Innovation and Science thus raising the profile of our expertise with EU policy makers. In 2011 Biosciences developed an EU

funding strategy aimed at increasing activity and securing funding from EU FP7 and Horizon 2020. We established an EU travel bursary and strategic networking fund (HEFCW funded 2011-14) to all researchers to support this. During the first 18 months the fund was accessed on 13 occasions and supported activities such as attendance at Marie Curie Fellowship workshops, EU call launch events, call application development activities, strategic EU networking events and EU conferences. As a result six FP7 cooperation call applications were submitted in 2012/13; 2 as lead and 4 as a partner (2 first time applicants). Of these, 3 projects were successful and have a value to biosciences of circa £3m. In addition, researchers were successful in securing 2 Marie Curie Intra-European Fellowships and 2 Marie Curie Initial Training Networks. During 2013/14 such activities continue and we will also focus on organising EU events for the University's 3 Research Institutes (the European Cancer Stem Cell (Biosciences led), Neuroscience & Mental Health and Sustainable Places).

The Danau Girang Field Centre is a collaborative research and training facility managed by a Bioscience employed Director (Goossens) and Sabah Wildlife Department, Borneo. Opened in 2008 the centre monitors sustainable co-existence of a burgeoning palm oil and tourism industry within the rainforest. Impacts include conservation action plans adopted by the Malaysian Government and global engagement with public interest groups.

Researchers within Biosciences maintain a wide range of activities with research institutions, charities, multinational companies and governments worldwide. Examples include:

- Membership; European Academies Science Advisory Council's Biosciences Steering Panel (Petersen)
- Advising the French Parliamentary Office of Scientific and Technological Evaluation on approaches to human embryonic stem cell use in research (Dunnett)
- Developing a diagnostic standard, adopted by the World Health Organisation (Wilkinson).
- Membership of the Malaysian Palm Oil Board, collaboration with the Canadian Government and multinational companies (Seven Seas and DuPont) to develop new oil crops (Harwood)

c. Strategy and plans: Our strategy (implemented via our I&E team) is to exploit key research strengths, such as stem cell biology and environmental management, to enhance our impact.

Economic Impact: Our strategy is to extend engagement with Fusion IP and other venture capital funders to translate research. There will be expansion of strategic partnerships and assessment for spinout potential for those disclosures deemed to have commercial viability e.g. NDS Ltd previously. We will also pursue disclosures that are unsuitable for spinout that can be licensed to industry e.g. BC3-13 Monoclonal Antibodies, licenced to Abcam, Eli Lilly, Hoechst, Millipore and Novus previously. New initiatives will include the development of Reference Centres with multiple companies, currently being pioneered through the University Research Institutes e.g. Eppendorf, Olympus and Zeiss.

We will continue to facilitate Knowledge Exchange with non-academic beneficiaries by enhancing:

- Knowledge Transfer Partnership funding, industrial research and CASE PhD studentships.
- Partnership opportunities via the HEFCW Strategic Insight Programme
- Our range of undergraduate, post-graduate and post-doctoral employability opportunities
- Clinical interactions, to which end we have made a number of key Professorial appointments, including Rosser, Li and Gray.

Through our Knowledge Exchange activities, we will develop further University level partnerships. Our partnership with GE Healthcare is an exemplar of this process and we are currently exploring potential synergies between our research expertise, their strategic R&D needs and industrial research funding opportunities at the regional (Welsh Government), national (Technology Strategy Board) and international levels (Horizon 2020). We aim to increase the number of spinouts from the current level (3 in past 5 years) primarily through Fusion IP, who support our two recent spinouts (Progenteq Ltd. and NDS Ltd.) Within the Welsh context funding will also be sought from the new Wales venture capital fund, which opened in 2013.

Environmental and Medical Impact

UK: We will continue to support research active staff to participate in science policy making at national and international level, exemplified by work with the Government's "Gene Therapy Advisory Committee" (Dunnett), and the UK National Environment Assessment (Ormerod). We will engage with policymakers, driving science and innovation policy in Wales via our membership of the Science Advisory Council for Wales. We will continue to develop and diversify our public engagement activities, audiences and partnerships, e.g. through increased media interaction (e.g.TV documentaries) and presentations at cultural (e.g. National Eisteddfod, Royal Welsh Show and Hay Festival) and science festivals (Cardiff and Cheltenham). Our schools outreach programme is expanding through a HEFCW [2012/14]-funded 'BioScientists in Schools' placement scheme and a RCUK [2012/15] funded Cardiff University schools partnership initiative. In addition, the I&E team are leading the University's involvement in the 2nd BBSRC Excellence with Impact Competition (January 2013 onwards). The central objective is to create an engaged researcher network, which will develop best practice and drive cultural change.

International: Biosciences is currently (2013) ranked in the top 100 global universities for life sciences by the Shanghai Jiao Tong University ARWU. Our strategic objective is to improve on this ranking through enhanced research and impact. We will continue to develop our international engagement programme, working worldwide with companies and Non-Governmental Organisations. Within Europe, FP7 has increased emphasis on SMEs and industrial research components; this trend is likely to continue into Horizon 2020. We will work closely with the University's EU office to administer applications and projects and promote EU networking via specific funding for travel to Brussels and between network partners, with support from the University (HEFCW) and from Welsh Government. In Malaysia our presence will be strengthened via collaboration with Sabah Wildlife Department. This will expand partnering and training schemes with NGOs and Universities and the palm oil industry. In China, we have a number of initiatives including increased involvement with the Cardiff University-Peking University Cancer Research Institute, the development of formal relationships with the Chongqing Training consortium and the Chinese academy of Science, and via Petersen's honorary Professorship at Jinan University in Guangzhou.

d. Relationship to case studies: Our approach is to identify and prioritise those areas of research with potential to translate into impact, our impact case studies being exemplars of best practice.

Economic Impact: Three of our case studies illustrate the impact we have had at different points in the innovation pipeline: early stage product and process development (Harwood), licensing products (Harwood and Caterson), and the creation of a spin-out company (Lloyd). As a result of the experience we have embedded a process for evaluating the business readiness of new discoveries and put in place resources to translate outputs effectively. This process is exemplified by the formation of NDS Ltd, initially funded via a DTI grant. By 2014, the company will develop a prototype product and service for its drug discovery tool. Biosciences is providing facilities and services to NDS Ltd and will help source additional funds and facilities.

Environmental and Medical Impact

UK: Researchers within Biosciences are active in the realm of policy development. This is exemplified by the impact case study of Ormerod who led the development of the water chapter of the UKNEA (published 2011). In addition, Ormerod was elected Chair of the RSPB (2012), the UK's largest environmental charity with a turnover in excess of £120M. Similarly, we influence policy development for neurodegenerative diseases, mental health, human stem cells and the search for alternatives to animal models.

International Impact: Our case studies also reflect international reach, for example in provision of a diagnostic technology adopted by the World Health Organisation (Wilkinson). The case study of Bruford also exemplifies the development partnerships in a number of international settings including both China and Malaysia. Researchers from the School are also pursuing strategic collaborations with researchers and non-academic users in the EU, Brazil, Peru, the US and Portugal; exemplars of which are highlighted in sections b & c.