Institution: University of Southampton

Unit of Assessment: 5 Biological Sciences

a. Context

The Centre for Biological Sciences (**CfBS**) has research impact in Molecular & Cellular, Biomedical and Environmental Sciences. CfBS is at the strategic core of the University-wide vision for interdisciplinary sciences, the Institute for Life Sciences (IfLS; created 2010; Director Smith). CfBS academics are members of this cross-Faculty forum which facilitates bioscience collaborations with physical, engineering and medical sciences. This context underpins CfBS impact especially in human and animal health, food security and environmental sustainability. CfBS has delivered industrial/societal benefit from its research with 3 spinouts since 2001: Southampton Polypeptides, Exosect (ICS 08 Exosect) and Capsant Neurotechnologies (ICS 07 Capsant). The context for delivering impact 2008-2013 is evidenced by 87 funded collaborations with external partners, from local to global, including 45 industries, 14 charities and 7 governmental organisations and public bodies. Consultancies bring a further 10 collaborations with external stakeholders. CfBS held 14 CASE PhD studentships, a further 17 industrially funded PhDs and 6 funded by charity which, with 49 research contracts, provided income of £9.2M. Patent applications have been made by inventors Keevil (PCT/IB2008/052455; *H. pylori probe*), Lillycrop (PCT/GB2010/050141; *Prediction of health phenotypes by methylation of CpG di-nucleotides/ groups inside specific genes),* Chad (US 13/415,069; *Confocal-like microscope using a super-oscillatory lens*) and Fox (US 61/843,272; *Cytosine variant detection*) and granted to Webb (US 8425945; *Methods and compositions for regulating biofilm development*).

The main non-academic beneficiaries of CfBS research are:

i) Pharma, biotech, animal health, crop protection, food industry: CfBS interacts with industry to improve human and veterinary medicine, food productivity and security. This includes new approaches to understand the relationship between brain inflammation and neurodegeneration in dementia (e.g. GSK and Lundbeck PhD CASE studentships to Teeling) and new tools for the study of neurodegenerative processes in vitro, leading to the launch of a spinout (Capsant Neurotechnologies, **ICS 07**). Expertise in epigenetics (Lillycrop) is informing nutritional requirements for infants supported by Nestec, Danone and Abbott Nutrition (> £3M). International links with Bayer Animal Health, Bayer Crop Science and Makhteshim Agan, underpinned by expertise in nematode biology, have applications in animal health and crop protection (O'Connor and Holden-Dye; 5 PhD studentships and contract research; £0.5M from industry), and have supported the launch of 3 new veterinary products, 2 in the review period (Profender™ and Procox™; **ICS 05**). CfBS has a sustained high profile in invertebrate biology and launched a spin-out company for new methods of pest control (collaboration and 2 PhD studentships with *'Exosect';* **ICS 08**). Applied research in biofilm ecology (Keevil and Webb) has led to clinical trials for new approaches to control drug tolerant infection. CfBS provides its strongest undergraduate students as one year placements (25 since 2008) to major pharmaceutical companies GSK, AstraZeneca, Novartis, Eli Lilly, Pfizer, Sanofi and Janssen-Cilag.

ii) Conservation and management of natural resources: Impact on sustainability is provided through expertise in ecology, biodiversity and bioenergy (Doncaster, Eigenbrod, Poppy and Taylor) in collaborations with 14 international and UK conservation partners including IUCN, Conservation International, International Centre for Tropical Agriculture, Panthera, Natural England, and Marwell Wildlife (**ICS 06**); 6 PhD CASE studentships and 1 fully funded PhD.

iii) Governmental organisations: Taylor delivered novel empirical and process-based models for predicting UK bioenergy crop yields in current and future climates. A series of maps resolved to 1 km^2 underpinned UK Bioenergy policy developments. These have been utilised in the DECC Bioenergy Strategy ('Bioenergy Report of the Committee For Climate Change') and are part of ESME (Energy Systems Modelling Environment) developed by the Energy Technology Institute.

iv) Charities and public sector: Long-term collaborations with the Alzheimer's Research Trust, Alzheimer's Research UK (ARUK), Multiple Sclerosis Society and Fight for Sight (Mudher, O'Connor, Perry, Teeling, Vargas-Caballero) have funded research in neurodegenerative disease and supported outreach e.g. ARUK public days (9/6/11; 1/4/13). Perry co-chaired a review of care of dementia and published national guidelines for ethical care (Nuffield ISBN: 978-1-904384-20-5).

v) Schools and colleges: CfBS promotes interactions with schools and colleges through regional and national activities to address RCUK objectives for increasing engagement with STEM subjects.

CfBS hold an RCUK Catalysts project (£150k 'Talk to US', 2013-2016) to engage disadvantaged schools and are part of a Wellcome Trust Society Award (£150k; 2012-2015 Authentic Biology) providing 6th form students with real research projects. Holden-Dye is BBSRC Regional School's Champion (food security). CfBS runs annual workshops and work-shadowing for school pupils, an annual Neuroscience Outreach Workshop for 6th formers, '*meet the researcher*' events and demonstrations for Life Lab (short-listed for BBSRC Excellence with Impact, 2012), reaching 1000 pupils each year. CfBS also contributed to the acclaimed Robert Winston Summer School (2013).
vi) General public: CfBS provides > 4 exhibits annually to Science & Engineering Day which attracts over 3000 visitors (BA 'Best Engineering Event', 2009). CfBS participates in the University 'Multidisciplinary Week' with public lectures, discussion panels and exhibitions, e.g. Poppy hosted a packed TedX event on sustainability (17/3/2013). The Wellcome Trust funded an exhibit at the Barbican ('Festival of Neuroscience 2013'; Neuroscience inspired fashion'; 5000 attendees) and a science/art project, Head in the Cloud (2013). Press releases publicise CfBS research; from 2010-13 there were 115 recorded items of coverage of which 22 were international, 66 national and 27 regional. 19 stories were covered by the BBC and 17 in national papers and magazines.

b. Approach to impact

Leadership and management are provided by the Director for Enterprise (DE; Holden-Dye) who is a member of CfBS Senior Executive Group. This links via the Faculty Associate Dean for Enterprise (Bartlett) to the University Executive Group and overarching strategy for impact.

Facilitation of relationships with non-academic user groups: DE provides an immediate point of contact for all external enquiries relating to non-academic users, and a flexible and dynamic approach to new opportunities. DE is supported in this role by a designated academic Business Fellow (BF; Werner to 2010; Teeling 2010-current). This provides the mechanism for matching industrial partners with academics by i) *mapping technologically relevant research activities undertaken by staff members*; ii) *targeting the promotion and advertisement of research activities of interest to the business community through technology network and business organised events* iii) *establishing introductory meetings* iv) *integrating CfBS activity with the wider University strategy*. DE consults with representatives of non-academic user groups through i) a Scientific Advisory Board (two from Pharma, a food retailer, a biotech representative, a media consultant, an educationalist), ii) an 'Entrepreneur in Residence' from Pharma who provides advice on specific aspects of industrial interactions (2008-2012, Dr Szekeres; 2012-current, Dr N Camp, Eli Lilly), and iii) Visiting Professors (Peter Freer-Smith, Government Chief Scientist for Forestry Research; Julian Burke, Chief Scientific Officer Leica- Microsystems; Alan Raybould, Syngenta Fellow). Together these advise on new routes to partnerships with non-academic user groups.

Supporting commercialisation: Research and Innovation Support (RIS) is a central team of >40 staff to facilitate interaction with business partners and support incubation of new businesses. A specialist legal team supports commercial contracts and IP management, as well as advice and training to staff on developing IP. CfBS has a dedicated RIS Collaboration Manager (Irvine) with relevant industry/sector experience responsible for guiding the exploitation route and negotiating licences. The Faculty Patent Panel, chaired by Bartlett, evaluates requests to file patents and costs of filing. RIS provides workshops for staff and students in entrepreneurship and intellectual property, to facilitate interactions with wider stakeholder groups to drive enterprise forward. RIS was key to spinning-out Capsant Neurotechnologies through its interactions with IP2IPO (**UoA 05 –** ICS 07 Capsant) and has supported patent applications (5 for 2008-13, 1 granted) and 2 applications to the BBSRC Follow-on-Fund (Fox, successful; Holden-Dye, pending).

Promoting an enterprise culture: Enterprise is part of each academic's annual performance review: Exceptional performance is recognised through the Vice Chancellor's Achievement Award (CfBS ECRs Quraishe and Puentener, 2012). Funds are available to support both outreach (e.g. public Annual Lectures) and enterprise (e.g. BBSRC "Sparking Impact", 2013). CfBS promotes an enterprise culture by participation in national competitions including BBSRC "Excellence with Impact" (2008-2011), Innovator of the Year (Holden-Dye and O'Connor; Bailey), SET for Britain (finalists 2010 and 2011) and Biotech YES (2 teams for each of the last 3 years). CfBS take part in a University Public Engagement Network (launched 2011) to share best practise in outreach. In 2012 CfBS established a group to promote enterprise and to capture impact, the '***Research Enterprise and Engagement Champions*' (*REECh***). Chaired by DE, REECh meets quarterly and includes Mudher (School's Liaison), Teeling (BF), ECR postgraduate and undergraduate

representatives, Marketing & Comms, Press Office and RIS. The ECRs produce a newsletter (now on edition 3) to highlight recent successes and promote opportunities.

c. Strategy and plans

Strategy: Our strategy is two-fold i) *to improve the pipeline for future impact case studies by creating an environment in which beneficial collaborations with external partners are facilitated and nurtured from an early stage* and ii) *to ensure that emerging impact case studies mature to generate tangible economic and societal benefit*.

Plan: We will refine the strategic plan for REECh on an annual basis so that it can evolve into an effective platform that identifies and supports opportunities for delivering impact for CfBS. We will employ new approaches to establish collaborations with external partners. Given the success of the BF in driving links with Pharma we will appoint another BF to encompass research relevant to governmental organisations and public bodies. The BFs will maintain a confidential database logging engagement with non-academic users permitting us to efficiently share routes of contact. We will increase internationalisation of our engagement with external partners by linking with University-wide initiatives. An exemplar is the University Industrial Sector Team (UIST; funded by HEIF) which aims to build links with the health sector. UIST coordinated showcasing of CfBS research at US Bio April 2013 (40 expressions of interest; 1 MTA signed Oct 2013) and a UIST 'Bench to Bedside' Conference June 2013 (120 attendees; >10 companies). We will strengthen links with regional external partners through participation in the IfLS Wessex Life Sciences Alliance, through engagement with University led negotiations for memoranda of understanding with key regional partners (e.g. DSTL) and through participation in a newly formed local business 'cluster' championed by RIS. We will widen consultation with non-academic user groups by increasing engagement of our Scientific Advisory Board via tri-annual meetings and identify new routes to link with a range of stakeholder groups and sectors. We will require all academic staff, as part of appraisal, to provide an annual impact statement to highlight research activities with translational, commercial, or public engagement potential. These will be reviewed by REECh to select emerging impact and ensure delivery of appropriate support and advice to the academic. In this way we will build the CfBS portfolio of economic and societal impact.

d. Relationship to case studies

***ICS 05 The fight against parasitic worms**:* This led to the launch of new veterinary medicines with an entirely novel, resistance-breaking efficacy against parasitic worm infections in animals. Bayer contacted CfBS with a request to elucidate the drug's mode of action; the case study exemplifies capability to respond to challenges posed by industry. A 15-year collaboration illustrates the confidence that the sector has in engaging with CfBS. Crucial to this is the established framework for supporting enterprise and innovation through RIS.

ICS 06 Preserving the integrity of the Mesoamerican Biological Corridor in Belize: This illustrates international impact of CfBS research in ecology and biodiversity translated to wildlife conservation. Flexibility in CfBS policy on income generation allowed an unusually high level of the project's Darwin Initiative grant to be invested in the host country (93%). CfBS educational programmes facilitated opportunities for knowledge exchange by giving host-country personnel access to University e-resources and by organising 13 CfBS undergraduates to spend 2 months in the host country working alongside undergraduates of Belize University.

ICS 07 Capsant: Advancing drug discovery through the development of 3D mini-organs: This delivered laboratory engineered tissues for testing pharmaceutical compounds. It exemplifies successful innovation of new approaches to scientific problems and the launch of new technology through formation of a successful spinout company, Capsant Neurotechnologies Ltd (rebranded as Organdot). The academic founders were supported by RIS from initial conception through company formation and financing. CfBS acted as an incubator, providing laboratory facilities before the company moved to independent premises.

ICS 08 Exosect: an innovative electrostatic technology for environmentally friendly pest control: This spin-out company pioneered new pest and disease control methods and reflects longstanding interests in pest management, pesticides and genetically modified crops from the 1980s onwards. Novel, non-toxic approaches derived from chemical ecological studies of pheromones led to early patents in the 1990s and foundation of a spinout company. A proactive and flexible approach to enhance impact of our research at the time together with central support for patent and IP development underpinned this successful venture.