Institution: University of Sussex

Unit of Assessment: UoA 5 Biological Sciences

1. Context

Biological Sciences research at Sussex ranges from environmental, ecological and biodiversity research with clear impact via national and international policy and planning; through research into the molecular, cellular and physiological basis of human disease with potential impact via improved diagnosis and treatment. Other activities, such as basic research into the evolution of behavioural and sensory functions, have less direct impact but address fundamental biology that underpins the broader research ethos.

The potential for impact has been well recognised in the UoA over the assessment period, as evidenced by submitted case studies that detail strong engagement with non-academic end-users of our research and resulting outcomes, particularly in health and the environment.

The main non-academic user-groups for the UoA's research are governmental and supranational organisations concerned with environmental conservation and health delivery, as well as NGOs, medical charities and patient advocacy groups. For-profit commercial enterprises have been a relatively small feature of end-user engagement in the reporting period. However, with the establishment of the Translational Drug Discovery Group (spanning UoA5 and UoA8), industrial engagement is becoming a substantial and growing part of our portfolio.

Research in the UoA benefits these end-users by, for example, elucidating biological mechanisms underlying disease processes that provide the rationale for improved diagnosis and disease management; or by providing procedures for evaluating the impact of pollution and environmental damage that inform programmes of remediation, conservation and biodiversity management.

The submitted impact case studies cover a broad range of impacts of both types, with case studies from Newport, Lehmann, Richardson and Caldecott/Jeggo/O'Driscoll addressing the diagnosis and management of genetic diseases and predispositions, while case studies by Ramsey and Stewart/Peck address the conservation and management of species and environments.

These case studies reflect only part of the UoA's research activity, and do not include the significant impact associated with the research of recent recruits to the UoA, including Atack, Goulson, Hughes, Lagnado, Pearl, Prodromou and Scharlemann. In particular, the considerable impact potential of the recently established Translational Drug Discovery Group does not feature in the current submission but, as with the work of other recent recruits, will form a significant component of impact submissions in future REF or REF-related processes.

2. Approach to impact

Our approach to impact is driven by the desire to change the world through our basic research and the translational opportunities it engenders. From the individual researcher to the institutional strategy, we champion impact in the widest sense; expanding the range and reach of our external engagement, investing in our enterprise pipeline through the Sussex Innovation Centre, building partnerships with users, beneficiaries and the general public, and ensuring that our outstanding research is communicated, celebrated, and used.

Direct participation

While basic research remains the core of our endeavours, considerable attention is paid to identifying aspects of our research that are amenable to commercial exploitation, or have relevance to the needs of commercial, governmental and not-for-profit organisations. Wherever possible, researchers have worked directly with beneficiary groups to facilitate translation of the basic science to impact.

Identification of opportunities for impact is facilitated by the University Research & Enterprise Office, which provides a regular digest of opportunities and supports networks of local industry and

other stakeholder groups. Within the School of Life Sciences, the grant-application pre-notification system brings opportunities for building impact into a proposal to the early attention of the Head of School (HoS) and Director of Research and Knowledge Exchange (DoRKE). This internal checkpoint both informs and aids submission of grant applications of the best possible quality, and creates a window through which projects with genuine potential for future impact are identified.

Advocacy and fundraising

Stakeholder engagement outside commercial, regulatory or governmental organisations (e.g. patient groups and 'citizen scientists') is well supported, and interactions with such groups that have delivered clear impact feature in several case studies. While less readily measurable, advocacy and fundraising by researchers in the UoA also play an important part in building scientific impact around our areas of research excellence.

For example, Peck and Stewart work with governmental and non-governmental organisations in Papua New Guinea and Ecuador, conserving 10,000 hectares of tropical rainforest and providing sustainable livelihoods for the local population. Ratnieks and Goulson, leading experts in the conservation of honey bees and bumble bees, have been extremely active in fundraising and advocacy, with influential media profiles, informing public opinion, NGOs and other agencies on best practice in bee conservation and management. Goulson brings exemplary community engagement via the Bumblebee Conservation Trust – which he founded in 2006, with >7,000 members and 12 staff, translating basic research into conservation actions, and winning the Lottery Award (Environment Category) for best Lottery-funded project.

A substantial part of the research in the Genome Damage and Stability Centre directly relates to understanding the origins and mechanisms of cancer. Faculty in the Centre play an active role in promoting the mission of Cancer Research UK in the local community, working directly with the CR-UK fund-raising team and engaging with local cancer survivors and their families.

Community outreach

While difficult to account and attribute, we believe that improving public understanding of biological sciences and the contribution they make to social and economic well-being is an essential component of our impact as researchers. Understanding of 'scientific method' and the importance of evidence-based decision-making are essential attributes of a mature and rational society that is able to make informed choices about the uses of science and technology, and have been a very strong philosophical theme underlying scientific research at the University of Sussex since its foundation.

Researchers in the UoA are very active in a range of community engagement and outreach activities, including patient advocacy groups (brain tumour, deafness, etc.), University of the Third Age, Ropetackle Theatre, local state and independent schools, beekeepers, and interest groups associated with the South Downs National Park. Of particular note are the research talks and demonstrations we contribute annually to the Brighton Science Festival, which have included the organisation of and substantial contributions to the 2010 '*Life, the Universe and Everything*' event, the 2011 '*Of All the Nerve!*' event, and the 2013 '*DNA Day*' with contributions on evolution, gene expression, and the history of the discovery of the structure of DNA. This community engagement is actively encouraged throughout the School and the University, and is explicitly recognised in the annual appraisal process at all levels.

The Genome Damage and Stability Centre hosted an open-day event in 2013 as part of its celebration of the MRC Centenary, providing exhibitions of science and art, and public lectures by researchers in the Centre.

Research groups in the UoA are regularly involved in direct engagement with local schools, hosting events where high-school students and sixth-formers experience the practicalities of laboratory research. We run an annual Science Teachers' symposium, attracting teachers from the state and independent sectors across the South East, providing contact with cutting-edge technologies and topical research in a continuing professional development setting.

Entrepreneurship and consultancy

Staff in the UoA actively engage in networking events organised through, and supported by, the

University Research & Enterprise Office and wider consortia. A number of staff have held Business Fellowships with the London Technology Network that have significantly increased exposure of Biological Sciences research at Sussex to a wider user-group community, and brought back best practice in developing entrepreneurial skills. Staff sustain a strong portfolio of consultancies with a range of companies, both in the UK and abroad.

Patents and companies

Osorio has developed a novel method for accurate image-based colour and spectral measurement based on ordinary digital photographs, without the need for expensive spectroscopy. This potentially 'disruptive' technology, marketed as Colourworker, has been patented in the USA (US Patent 8,044,969, granted October 2011) and the EU (EU Patent 1854277). Colourworker has many potential applications in medicine, where colour is a routine diagnostic parameter. Osorio is involved in a Proof-of-Concept study in collaboration with Mr C. Nduka, and Dr M.J. Hallam at the McIndoe Surgical Centre and Queen Victoria Hospital, East Grinstead, where Colourworker has been integrated with conventional photography to monitor the condition of scars following breast surgery. Osorio is pursuing follow-up studies to validate the technology in other clinical applications, and to develop smart-phone implementations for routine use.

Pearl is the founder and a Director of Domainex – a biotech company applying proprietary technologies as a service to the pharmaceutical industry and in support of an 'in-house' drug-discovery portfolio focused on cancer and immunological indications. Pearl's involvement with Domainex has brought multiple mutual benefits to the UoA and the company, including the sponsoring of a CASE studentship, a shared income stream from commercial X-ray protein crystallography of protein-drug complexes, and the involvement of leading figures from the biotech industry with the advisory board for the Translational Drug Discovery Group, which is chaired by the COO of Domainex, Prof. Trevor Perrior.

Working with industry

Interactions with industrial research users are enhanced by the recruitment of the Directors of the Translational Drug Discovery Group, Prof. Simon Ward (UoA8) and Prof. John Atack, who have joined the University directly from successful careers in the biotechnology and pharmaceutical industries. As well as bringing a wealth of contacts and networks from their industrial experience, Atack and Ward have injected a strong industry-facing impact ethos that is resonating throughout the research activities of the University in UoA5 and UoA8. In particular they have introduced the concept of a 'Steering Committee' to advise on direction and potential commercial and therapeutic opportunities. This has a strong representation from industrial specialists who would be likely collaborators and end-users in translating the outputs of the Translational Drug Discovery Group to impact.

The approach of the Translational Drug Discovery Group is already generating funding successes that are highly likely to lead to impact in the future. For example, in collaboration with a biotechnology company, reViral Ltd, the Translational Drug Discovery Group has been awarded ~£1.4M by the Wellcome Trust Seeding Drug Discovery Initiative (SDDI) for 'A stream-lined lead optimisation project with the potential to deliver first-in-class small-molecule inhibitors of Respiratory Syncitial Virus (RSV)'. Most recently the team has been awarded a ~£3.9M SDDI grant for the development of allosteric modulators of AMPA receptors for cognitive enhancement in schizophrenia. This and multiple similar projects have the potential for considerable future impact both on the economy, by adding commercial value to UK biotechnology activity – especially at SME level – and on health and well-being by providing new treatments for cancer and a range of neurological, neurodegenerative and psychiatric diseases.

Staff have successfully utilised connections with industrial and other non-academic research-users to secure sponsorship of multiple CASE awards for PhD students (see REF5).

3. Strategy and plans

Our impact strategy aims to support researchers by providing effective access to administrative structures, professional advice and, where relevant, additional funding, to allow them to translate their basic research into impact, without unduly distracting them from the curiosity-driven science

that motivated their project in the first place.

Looking forward with this strong impact agenda, we identify a number of areas in the UoA where new developments in basic science and/or new appointments are likely to generate tangible impact for the future not already covered in the present impact case studies. For example, on-going research by Richardson and Kros has the potential to improve the use of aminoglycoside antibiotics to minimise the current serious risk to hearing in patients receiving these otherwise valuable antibiotics. The work of Lagnado, a recent appointment, offers insights into the basic wiring of the retina that has the potential to impact the treatment of visual impairment and trauma. Work from Hoffmann is leading to a better understanding of failures in meiosis, with implications for the treatment of female infertility, while work from Caldecott, Carr, Downs, Hochegger, Murray, Oliver and Pearl is leading to the validation of a raft of new targets for therapeutic intervention in cancer, with the prospect of collaborative translational development with the Sussex Translational Drug Discovery Group and external commercial and medical-charity partners. The pioneering work of Goulson, a recent appointment, is likely to change the use and policies relating to neonicotinoid pesticides, while the work of Hughes and Goulson is highly likely to change current attitudes to the import of bee species to the UK. The cross-disciplinary work of Scharlemann – which bridges ecology and science policy – in evaluating the efficacy of current approaches to biodiversity management worldwide, will change the way governments and NGOs assess the success of environmental measures and frame new initiatives in biological sustainability.

Successful translation of this research will be facilitated and closely monitored by the University 'Excellence with Impact' team, facilitated by a 'Sparking Impact' award from the BBSRC, and supported by a dedicated Research Impact Officer within the University's Research & Enterprise Office. An 'Impact Champion' appointed by the School will work with the HoS and the research leaders involved to identify the points of progress at which potential impact is being generated, and will initiate promotional activities via the extensive business and community networks of the Research & Enterprise Office and the Sussex Innovation Centre in order to bring the impact to the attention of the relevant stakeholders and potential commercial partners. In parallel, opportunities for the formal protection of intellectual property arising from the research will be identified and put before the University Enterprise Panel for consideration for the funding of patent applications and further development work that may be required for bringing concepts closer to market.

4. Relationship to case studies

The chosen case studies directly reflect the approach to impact, in which the direction and quality of the underlying basic science remains fundamentally curiosity-driven at the core, but from which opportunities are recognised, embraced and developed with identified stakeholders. For example, five of our research groups (Lehmann, Richardson, Caldecott, O'Driscoll, Jeggo) are engaged in exploiting their extensive and long-term interest in identifying new DNA disease-related human genes and mechanisms to aid the diagnosis and management of human genetic diseases with the relevant pathology (three impact case studies), while Newport's work has transformed the management of a major debilitating condition affecting vulnerable parts of the developing world. Similarly, the School has a very strong reputation and historical standing in conservation and ecology, which has translated into direct impact through the work of Ramsey – the development and application of approaches for the accurate measurement of contaminants in soil – Peck and Stewart. The latter two investigators have a long-term interest in rainforest conservation and, consequently, have influenced government and NGOs in Ecuador and Papua New Guinea, resulting in the conservation of >10,000 Ha of tropical rainforest and providing a sustainable economic infrastructure for the local community.

Together, these case studies exemplify our approach to impact – encouraging individuals to exploit their organic research links with patient groups (diagnostics), local communities (conservation and disease prevention), and governmental organisations (contamination estimates).