Institution: University of York

Unit of Assessment: 5, Biological Sciences

a. Context

Fundamental biological research at the University of York (UoY) is being channelled to address three major global challenges of the 21st century.

1. **Health and disease.** Our research provides societal benefits to NGOs, the medical profession and patients, as well as economic benefits to pharmaceutical and agrochemical companies.
2. **Sustainable production of food and fuel.** We develop novel products and processes to alleviate food shortages, mitigate climate change and provide market opportunities for industry and agriculture.
3. **Ameliorating the effects of environmental change.** Our work is bringing major global benefits to biodiversity and to governmental and NGO policy development.

We organise impact-directed research through three interdisciplinary research centres, which work with external partners to develop effective solutions to complex real-life problems.

The Centre for Immunology and Infection (*CII*, est. 2010) translates fundamental research on the pathogenesis of disease, and develops new approaches to disease prevention and treatment. For example, *CII* recently conducted successful Phase I clinical trials of novel HIV vaccines and microbicides with the potential to achieve major global health benefits.

The Centre for Novel Agricultural Products (*CNAP*, est. 1999) focuses on discovery and development of pharmaceuticals, biofuels and other products from plants and microbes, generating impacts relevant to all three global challenges. *CNAP* supports large multi-investigator programmes that involve and benefit pharmaceutical (e.g. GSK), biofuel (e.g. Novozymes, Shell) and agricultural (e.g. Syngenta, BASF, East-West Seeds) companies.

The York Environmental Sustainability Institute (*YESI*, est. 2011) brings together natural, physical and social scientists to deliver world-leading interdisciplinary research and stakeholder collaborations to benefit industry, NGOs, advisory agencies and policy makers (e.g. Nestle, DLF Trifolium, Joseph Rowntree Trust, Design Council, ADAS, Natural England).

b. Approach to impact

Facilitating activity leading to impacts. We support staff by using the capacity and collegiality of our research centres and foci to facilitate activities that lead to impacts. The following mechanisms have been used to:

- **Forge connections with non-academic partners.** Research Innovation Office (RIO) staff and Biology's Industrial Placement and Industrial Liaison Officers help us to establish external collaborations. In 2013, this facilitated 10-12 month placements for 150+ students and enabled >70 academic and research staff to visit ~90 businesses and other institutions. In addition, *YESI* has a Business Development Manager to support interactions with industry/NGO/policy partners. We support visits and secondments to and from potential partners to develop ideas beyond initial contact, leading, for example, to *CNAP* obtaining a BBSRC Flexible Interchange Programme (FLIP) award with GSK. We provide departmental resources for workshops and conferences in which external partners participate (e.g. *YESI* holding an industry-facing workshop on green manufacturing in 2011) and fund travel to attend meetings where contacts with prospective non-academic partners can be made.
- **Obtain funds to develop impacts.** RIO and Biology's Research Support Office and Peer Review Colleges supported >50 successful impact-driven contracts, awarded by government (total of £3.1M, 2008-13) and industry (£3.4M + £0.8M *Technology Facility*, *TF*, commercial income). UoY strategic funds pump-primed the establishment of *YESI* (£0.5M), which returned £3.3M of external impact-oriented income in 2011-13 (with a further £6.4M under submission). The *Centre for Low Carbon Futures* (*CLCF*), a consortium of regional universities coordinated by the Department, responded to Yorkshire Forward RDA opportunities to pump-prime (£528K to York, several million overall) multi-disciplinary research to underpin the development of

sustainable biorefineries, leveraging an additional £15M to the partner organisations.

- **Translate and commercially exploit research for economic and societal benefit.** We appointed a Skills Development Coordinator and all academic staff participated in impact-relevant training during the REF period, such as departmental and UoY courses and briefing sessions in enterprise (including start-ups) and IP. RIO assisted Biology staff to produce six spin-outs active in the assessment period (Amaethon, Bioniqs, Cizzle, Novocellus, Pro-Cure Therapeutics, Xceleron). SME Cizzle Biotech, for example, employs three people directly and has a commercial development partnership with industry leaders Fujirebio Diagnostics Inc. to develop and market Cizzle's Ciz1 biomarker as a clinical immuno-assay for early-stage lung cancer detection. Pro-Cure partnered Stem Cell Therapeutics Corp. to develop and test stem cell therapies for prostate cancer; involving drug testing agreements with AstraZeneca and Geron Corp. RIO also assisted with IP, overseeing licensing agreements with East-West Seed to commercialise *CNAP*'s *Artemisia* varieties (see Case Study), sufficient seed being sold in 2013 to produce up to 120 million Artemisinin Combination Therapy (ACT) treatments for malaria sufferers in the developing world. Our centres provide a focus for translation: *CII* partnered Okairos Srl to develop a leishmaniasis vaccine, and Biology's *CNAP* and Chemistry's *Green Chemistry Centre of Excellence* jointly established the *Biorenewables Development Centre* in 2012, a not-for-profit company providing industry with novel bio-based processes to convert plants and biowastes into new high value products. It has secured ~£10M from UK Government, EU Regional Development Funds and commercial R&D contracts to work with a broad range of SMEs and large multi-national organisations, helping to develop business growth in the biorenewables sector. Similarly, *CNAP* collaborated with GSK to develop a new high yielding noscapine–morphine poppy; noscapine is used in cough medicines and is undergoing clinical trials as an anti-cancer compound. This work has generated a novel supply chain that represents 25% of GSK commercial production of noscapine in 2013.
- **Disseminate knowledge outside academia to inform policy-makers and the public.** Biology staff and students participated in over 200 public science and science/policy events, reaching at least 18,000 people; with additional activities reaching ~5,000 children in 140 schools. Biology appointed External Relations and Web Support Officers, who, with the University Press Office, trained staff and postgraduates to communicate research and impacts. They provided assistance with press releases and distributing them to the media, set up interviews, and disseminated information and images. This resulted in a ten-fold increase in Biology media stories from 2008 to 2012, making us the most productive department for media outputs at UoY and extending the reach of our research findings.

Motivating staff has been achieved by recognising and rewarding impact-relevant activities. We provide staff with career-progression, workload incentives, and flexible working to enable them to realise their aspirations to translate research into impacts that are valued by society.

- **Monitoring and mentoring.** The Department introduced an annual census during the REF period that captures impact-relevant activities carried out by staff, thereby incentivising impact activities and their efficient reporting. Impact activities are discussed with mentors during annual performance reviews, and we mentor ECR staff to establish contacts leading to impacts. Beale (an ECR), for example, obtained funding in 2012 from the Government Agency Natural England to carry out policy-motivated risk assessment of the threats to species from climate change. This arose from mentor Chris Thomas' contacts, with administrative support from *YESI*.
- **Encouraging participation and recognising impact.** We encourage staff to participate in impact-related activities, which feature in almost all departmental staff meetings and awaydays. We participated in BBSRC's Excellence with Impact programme, and Graham was a BBSRC 2013 Social Innovator of the Year finalist. Over 80% of our academics undertook impact-relevant activities in 2008-13, such as establishing spin-out companies, collaborating with businesses, disseminating knowledge, and engaging with policy makers, indicating that active engagement and participation in impact activities is widespread and embedded within the Departmental culture.
- **Resourcing.** Departmental Research Committee pump priming funds (£74.5K in 2012), the UoY Central Research Priming Fund (£144K to Biology in 2011-13), the Environmental Research Initiative (£200K in 2008-10; giving rise to *YESI*) and the *Centre for Chronic Diseases and*

Disorders (*C2D2*; £1.4M to date) supported projects with external non-academics. *C2D2* is a joint University-funded (via the Wellcome Trust) inter-departmental network (formed 2011 and directed by Kaye) that addresses illnesses and disabilities of infectious and non-infectious origin. PhD projects with CASE partners had preference in studentship allocations throughout the REF period, helping to promote impact activities by PIs and PhDs.

- **Workload and flexible working incentives.** Monitoring in our annual census enables senior management in Biology to take account of impact activities within workload assessments. Workloads were adjusted for staff associated with the strongest impacts (section D), and Coverley was provided with contract flexibility to develop Cizzle Biotech.
- **Promotion incentives.** Biology contributed to the University's review of promotion criteria, strongly supporting the decision to recognise: 'Enterprise, innovation, and other activities contributing to knowledge transfer with business, the public sector and the community'.

c. Strategy and plans

Our overall strategy is to (i) target specific research areas for support to ensure the translation of research into *major* impacts, and (ii) encourage and facilitate *all* staff and students to engage in impact-related activities appropriate for their stage of career and area of research. We appreciate that impacts can arise through unexpected discoveries and interactions, and that the range of impact activities is extremely broad. Our impact strategy is to:

Support the growth of impact priority areas. We recognise that research addressing the three major global challenges has given rise to our most significant impacts, and these areas have been selected for consolidation and expansion. Capacity is being increased through staff recruitment, support for staff, and new infrastructure. Collegiality is being developed through new networks and centres, working in close collaboration with business and other stakeholders. The priority areas are:

1. Health and disease. A seamless link in biomedical research between Biology and the Hull-York Medical School (HYMS) has been achieved by co-locating 11 HYMS faculty in Biology, in *CII*, from 2010 onwards. Further translational opportunities will be provided by the recruitment of 7 additional academic staff in Biomedicine (REF5), in infectious disease, neurological and neuromuscular disease, regenerative medicine, and cancer. The *CII* provides research and clinical links, with facilities that form part of the new University / York Hospital NHS Foundation Trust Clinical Research Facility. From Oct 2013, *CII* will also host the NHS's sexual health clinic. The full integration of fundamental, translational and clinical research will remove barriers and enhance collegiality, increasing our capacity to improve the health of millions of people. Our planned impacts include: Development of a leishmaniasis vaccine; HIV vaccine and microbicides development; Novel diagnostic test for lung cancer; Tissue scaffolds for bladder repair; New drugs to attack prostate cancer stem cells; and New natural products from high-yielding poppy varieties for use as cough medicines and anti-cancer drugs.

2. Sustainable production of food and fuel. Capacity has been increased in 2013 by the appointment of 2 Chairs and 1 ECR in fundamental plant sciences to underpin research in crop development. Forthcoming impacts that are being developed include: Development of drought tolerant rice plants (supported by £2.2M from BBSRC to *CNAP/YESI*); Novel lignocellulose degrading enzymes for biofuel production; Establishing biofumigation as a sustainable method of crop protection; and Improving oil palm sustainability. In 2013, *CNAP* Director Graham led the 'BioVale vision' for a regional Yorkshire and Humber Hub for sustainable bioscience applications, focussed on biorenewables, launched in collaboration with Science City York and the City of York Council. This will form a major platform for future impacts, with two of our three BBSRC strategic LOLAs that start in 2013 linked to BioVale. We have also announced (2013) a joint *Initiative in Agrifood Resilience* with Fera (Defra's Food and Environment Research Agency) to address the key issues of food security and environmental sustainability in a way that will ultimately benefit the rural economy and sponsor innovation in agri-technology.

3. Ameliorating the effects of environmental change. Capacity has continued to be built by the recruitment of 5 new lecturers in the REF period, and of Hartley as the first Director of *YESI*. Skills-sharing and critical mass will be strengthened further by the physical relocation of the Environment Department adjacent to Biology in 2015. Our planned impacts include: Protecting ecosystem

services; Improving conservation policy under climate change; Increasing resilience and reducing waste in global food supply chains; Managing emerging contaminants such as nanomaterials; and Increasing the sustainability of consumption. We will also prioritise developments that combine multiple benefits, such as sustainable agricultural production of plant-based pharmaceuticals, greenhouse gas mitigation by the efficient use of agricultural wastes, and health benefits of the environment; we will soon launch the inter-departmental *York Centre for Global Health and Environment* to further develop interdisciplinary research and impacts across Biology, Environment, Chemistry and Health Sciences.

Support activities to generate impacts. We will provide support for a wide range of activities to exploit the impacts of our research. Our strategy is to be flexible, using a goal-oriented approach. Support is tailored to the different scales of reach and significance of different projects, and to our wide range of commercial- to policy-oriented partners. Projects and applications to or with an external partner are supported by Biology's Research Support Office and reviewed by our Peer Review Colleges (see REF5). Beyond initial contact, we encourage co-working between academic and non-academic partners as this is critical for achieving the greatest impacts. Co-working ensures that academic and non-academic goals are aligned and provides intellectual co-ownership (and sometimes formal IP sharing), such that non-academic partners can act rapidly on the new information or potential products.

Ensure continuity. Our research centres are designed to encourage growth of our impact culture. Continuity is ensured because key roles in the management structure of the Department have responsibilities for impact, and we have appointed the Skills, Industrial Liaison, and Communications positions described above. These positions all directly link to the Departmental Strategy Group, the senior management group within the Department. Hence, all decision-making is strongly influenced by our impact aspirations, needs and successes.

Support individuals to generate impacts through training and career development. We support specific training of staff and research students to help foster their capacity to interact effectively with external partners. This includes *inter alia* the availability of training in IP, SMEs, and outreach skills. We support time away to attend external training courses relevant to the development of impacts, and secondments to (and from) partner organisations. Impacts are valid criteria for sabbaticals, workload adjustments and promotion.

d. Relationship to case studies

Facilitating activity leading to impacts. Our case studies involve staff associated with impact-focused research centres, and four of the five relate to our priority global challenges. The goal-oriented and collaborative nature of *CNAP* enabled us to develop reciprocal understanding of the capabilities and ambitions of York researchers, funders and industrial partners. This ensured rapid progression from discovery to impact for our two industrial case studies; e.g. the *CNAP* research-to-commercialisation of new varieties of the medicinal plant *Artemisia annua* took just 7 years. Our three policy-relevant case studies represent long-term interdisciplinary interactions with national and international NGOs, governments and intergovernmental bodies. This experience and the success of *CNAP* motivated us to establish *YESI* and *CII* during the REF period to increase the number, reach and interdisciplinary nature of future impacts. Pump priming (e.g. Hill for a joint impact project with Environment), prioritising CASE PhDs, and media support (e.g. alerting policy-makers to Thomas C's 2012 *PNAS* paper) helped the development of our case study impacts.

Motivating staff. Fitter, Graham, Hill and Thomas were supported through workload considerations (e.g. teaching alleviation for Fitter when on the Science Advisory Council for Natural England and steering committee of the Defra Lawton report). Impact achievements have been rewarded by promotion of Hill to a Chair in the REF period, and of Thomas C and Graham to higher Professorial grades. The Department supported *Emeritus* Professor Mark Williamson's continuing impact activities through provision of space and financial resources.