Institution: University of Abertay Dundee

Unit of Assessment: 5

a. Context This Unit integrates research from across Abertay, providing practical bioscience innovation for business, society and government. Underpinned by research in cancer, systems biology, food and drink bioscience, nanotechnology, microbiology, physiology, genetics and bioethics, this Unit sits in the context of a University research agenda that drives a few focused, inter-disciplinary groups:

- **SIMBIOS** (Scottish Informatics, Mathematics, Biology and Statistics Centre), linking complex behaviour of individual organisms and the bio-physical structure of their environment;
- **WhiteSpace**, a cross-University research group integrating computer arts, computer science, psychology, sociology, biological and environmental sciences;
- **CCSB** (Centre for Cancer Systems Biology), a partnership of Universities combining complex systems modelling and interactive visualization (inc. strong links to industry & **CMCBR**);
- **FIA** (Food Innovation @Abertay), a practical research and innovation support service for the food and drink industry, offering tailored and creative solutions to business challenges.

Working as part of these University groups provides the Unit with pathways to impact through stakeholders with which these groups interact. For example, **CCSB** and **WhiteSpace** have strong links to commercial industry; and through **SIMBIOS** and **FIA** we have added value to SMEs. The mix of disciplines that make up this Unit and these University groups means we are able to build teams to suit industry demand. We interact with the following groups, as detailed in (b) below:

- Industry partners: e.g. we have developed and commercialised a new biotech instrument (Case Study 1) and novel drugs in collaboration with Cyclacel Pharmaceuticals Inc. (Case Study 2).
- National industry/ trust partners: e.g. we have developed modelling approaches originally conceived for gene flow in plant systems (SIMBIOS) to study hospital acquired infection spread within wards (as a KTP with NHS Tayside);
- SMEs: through Food Innovation@Abertay and others we have assisted >140 SMEs from key economic sectors to innovate. Projects range from new product development to the development of new sensory analysis software.
- Consultancy in companies: highly skilled scientists from the Unit have taken up specialist roles as non-executive directors and members of scientific advisory boards for local and international biotechnology and biopharmaceutical companies (e.g. BioteXel Consulting, LinkCore Pharma Ltd, Biotech Scotland Ltd, Scientific Technological Service Ltd and Norton Scientific Inc.)
- Society and Public Understanding: we are very active in dissemination to societal groups including politicians, industry representatives and bodies, lay audiences and schools.

Our work is stimulated by an overlapping interest between our research direction and stakeholder needs. Our commitment to impact is motivated by a desire to contribute to the sustainability of the national environment and economy. We recognise the virtuous circle that undertaking industry-facing activity promotes; research with impact offers us a diversified funding portfolio to allow us to:

- Develop core research competencies (with industry problems as exemplar case studies);
- Stimulate new teaching provision, e.g. our new MProf Food & Drink Innovation was designed with stakeholder input, is supported by industry (through mentoring and teaching delivery) and has industry workforce within its student cohort;
- Ensure industry involvement in the design and delivery of our taught programmes to help make our programmes vibrant and relevant, which is essential in our operating context.

b. Approach to impact The Unit is well geared for impact and we adopt a differentiated approach to interacting with stakeholders, mixing long-running partnerships with the formation of new relationships, aiming to provide agile responses to new opportunities, and participate in networks that help to market our work and our work with other well-established Abertay RKE groups. In all cases we seek to maximise the impacts and benefits to the stakeholder and ourselves.

Some of our most impacting work is founded on long-running partnerships with stakeholders. For example, our impact case studies are founded on c.16 and c.11 years of interactions with Optokem Ltd. and Cyclacel Pharmaceutical Inc., respectively. In the case of Cyclacel Pharmaceutical Inc. on-going involvement in the discovery and development of a novel anti-cancer drug Seliciclib, has helped underpin a main area of focus for the Unit – Cancer Systems Biology – which is bolstered by academic and pathology collaboration with St Andrews and Edinburgh

Universities. Importantly, we do not depend on this depth of interaction for all our impact, as our reputation to deliver in key areas can attract company interest. For example, a new partnership with Macphie, an innovative food and drink company, was stimulated by our reputation and impact through FIA and our food & drink agenda. On a project co-funded by Macphie and Interface Food & Drink (£30K) we have developed an interactive software product to support sensory analysis for testing food products that Abertay will co-license. Again, based on industry track record, we have recently begun a funded project (£100K, co-funded by Interface Food & Drink) with Agrico, an international seed potato production company (2011 turnover of €208M) who are seeking innovative sensory analysis modelling, simulation and interactive visualization (work currently in development). The latter serves as an exemplar for our agility to react to opportunities. Agrico saw some adjacent work of ours (on cell signalling visualisation) and engaged in discussions on their business needs. We then built a mixed-discipline team to address those needs. Another example is that of a studentship supported by Lallemand (large multi-national). Our reputation in yeast biotechnology attracted interest, resulted in consultancy work and then sponsorship of PhD students - one investigating cell surface structure-function relationships in industrial yeast strains using nano-scale approaches (atomic force microscopy and Raman spectroscopy). In addition to us pulling collaborators in, we also push our innovations out. For example, our research on cancer biology and mechatronics allowed us to develop through Optokem Ltd. a multi-disciplinary collaboration which led to the formation of a new company - Norton Scientific Inc. – with whom we continue to work on the development of instrumentation for the biopharmaceutical market.

We are part of BioDundee, a partnership between the public, private and academic sectors, which aims to facilitate cooperation between Dundee City Council, Scottish Enterprise, academia and private enterprise. Members of staff have developed relationships with local and international biotech and biopharmaceutical companies through academic consultancy, joint research and development projects, joint supervision of undergraduate, postgraduate and research students and industrial visits. Examples of jointly supervised UG and PG projects range from investigations into the nutritional value and antioxidant activities of particular primary foods, to the development of novel diagnostics based on ferratin fusion proteins that contain magnetized iron ions with a local SME (Integrated Magnetic Systems). In addition, Unit staff are active members of the European Biotechnology Thematic Network Association (EBTNA) - a leading organization of biotechnology professionals in Europe. Partnerships in Scottish Government/ EU funded consortia are also important to this Unit to foster interaction with public sector, industry, and academic collaborators: we are a partner in the Scottish Biofuel Programme (next generation biofuel from renewable resources), a recently approved Industrial Biotechnology Innovation Centre (innovation for product development and manufacturing processes), are the University hub for Scotland Food & Drink Skills Academy (recommends and develops training and education across Scotland), and are a lead partner University for Interface Food & Drink (driving sector KE in Scotland).

The Unit has contributed to the well-established SIMBIOS and Urban Water Technology Centre (UWTC) groups, which gives us impact beyond our size. For example, UWTC leads LoCal-Net**,** our Low Carbon Land Use Innovation Network (ERDF-funded), which coordinates R&D and innovation in low carbon activities for SMEs across Scotland. Project staff (to which we contribute) visit SMEs to proactively identify areas where partnership working is needed to progress R&D or innovation projects; To date LoCal-Net has encouraged 123 SMEs to innovate products and services that contribute to a reduction in greenhouse gas emissions, protecting 4 SME jobs. This kind of activity, including KTPs (4 in the period for this Unit), Charitable Trust, EU and Innovation awards, are important to Abertay. Early career staff are fully supported by senior staff and our Research, Enterprise and Innovation Services office (costings, applications, contracts, NDA and management of IPR) to engage with research and develop their own capacity and potential.

The Unit recognizes the importance of public understanding and engagement in science, particularly in biotechnology where changing societal behaviour may be an important driver towards growing academic strength in the UK and influencing Governments. Abertay employs 2 STEM outreach coordinators and staff in the Unit contribute directly to outreach programmes, e.g.:

- The Tayside Space School targets age 9-12 yrs audience, delivering a series of events with the support of a NASA astronaut and Educator (approx. 500 pupils selected from 20 schools);
- Science Roadshow delivers basic science experiments to age 12-14 yrs pupils since 2007, reaching an estimated 12,000 pupils over the assessment period in local regions;
- Dundee Science Festival, Women in Science and Café Science events: co-organised by

researchers from the Unit across institutions in Dundee.
In addition, research was demonstrated to eminent visitors (including: Alex Salmond; David Gani; Alistair Darling; John Swinney; David Willets), and members of this Unit have contributed to the publication of 8 books and 19 book chapters during the REF period.

c. Strategy and plans Our impact strategy is integrated into a new 5-year Abertay-wide RKE strategy, founded on 4 cross-Abertay themes (Environment, Security, Society and Creative Industries). These themes recognize our major income streams, which includes a substantial fraction of KE. Moreover, our RKE strategy management team includes theme leaders that are very experienced in KE provision (especially in Systems Biology and Food & Drink). For Abertay the R-KE link is an essential element of this 5-year strategy. We are providing internal pump-priming funds to stimulate KE activity to enable researchers to attract external funds. We will combine University-led R-KE with Unit activities that supported impact in our larger research groups. To support our ambition to be a centre of excellence for inter-disciplinary research, innovating practical solutions for business, society and government, our strategy to achieve this for the Unit is:

- for all researchers to continue to have a translational approach to research activity;
- to encourage researchers towards inter-disciplinary collaboration;
- for researchers to have a parallel approach to dissemination of research findings (e.g. academic and end-user facing publications);
- for the University to value equally knowledge transfer activities and traditional research outputs.

The Unit has invested in the development of strong links with industry through the employment of researchers experienced in working in biotech / food companies. Abertay will continue to invest in researchers and groupings that have the potential to produce excellent research with real economic impact. In particular, the Unit will build on successes and continue to attract researchers with an international reputation in quantitative biology. The Cancer System Biology group will continue with its ambitious programme developing highly interactive modelling tools to understand drug action at both cellular and tissue scales in partnership with the Lothian Health University Hospital Division. We will continue to grow the impact of our food & drink R-KE through leveraging our already strong industry links to develop more substantial work-programmes and long-term collaborations.

We will also respond to new developments nationally. SFC are supporting new pathways to stimulate industry-academia partnerships in the areas (among others) of big data (Data Lab, under negotiation) and healthcare: the Digital Health Institute (£11M) and Stratified Medicine (£20M). Our modelling-simulation-visualisation framework is well aligned to the Data Lab (creative industries solutions to big data problems) and Stratified Medicine (cancer drug therapy); our involvement with the newly formed Industrial Biotechnology Innovation Centre (total funding to the value of £21M) will also be a focus to our future strategy.

To further optimise our Outreach activity we have created an Outreach and Public Engagement Network (OPEN) and work with the University's centralised and coordinated Communications Centre which aims to manage and influence our reputation for excellence and ambition in applied research. This includes a programme of media releases designed to generate coverage in news media locally, nationally and internationally and in specialist media, supported by engagement with key audiences and stakeholders. The Unit interacts with the Communication Centre through a dedicated officer: this ensures knowledge of on-going research within the Unit and optimizes the timing of press releases to maximize impact. In partnership, articles have been written for local and international newspapers, and research achievements of staff have been covered in radio and TV programmes (approx. 30 p.a.).

d. Relationship to case studies Our case studies demonstrate our strategy of engaging in translational research, working closely with bio-pharmaceutical companies as end users, utilising multi-disciplinary teams, and having appropriate dissemination strategies. Case Study 1 describes the development and commercialization of light-scattering instrumentation for the biotechnology industry following purposeful collaboration between a cancer biologist and mechatronics academic at Abertay with a company Chief Scientist. Case Study 2 illustrates a determined long-term commitment towards discovery and development of an anti-cancer drug in collaboration with Cyclacel Pharmaceuticals Inc., which has involved our researchers seeking out specific *in vivo* experimental facility and clinical expertise to augment our own particular contribution and discipline expertise.