Institution: Heriot-Watt University

Unit of Assessment: UOA 6, Agriculture, Veterinary and Food Science

a. Overview

Research in Food Science at Heriot-Watt University (HWU) is organised under three themes, (a) Toxicology, (b) Brewing & Distilling and (c) Food & Nutrition, within the School of Life Sciences (SLS). HWU's collective vision is to be world-leading within all of its specialist areas of science, technology, engineering and business and a new interdisciplinary approach to research across HWU provides an effective structure for addressing research challenges, bridging traditional discipline boundaries and allowing more effective engagement with industry. For us, this provides links across biological, environmental and physical sciences, engineering and mathematics through a Life-Physical sciences theme. The Toxicology group (**Stone**, **Panagiotidis**, **Johnston)** is a new theme since RAE2008, established by recruiting leading researchers in the field, investigating the human health impacts of engineered nanomaterials. The International Centre for Brewing and Distilling (ICBD) (**Speers, Hughes, Mitchell, Morris**), established in 1988, is a unique centre in the UK HEI sector, spanning all sectors in the global brewing and distilling industries, combining research and knowledge exchange. Our Food and Nutrition research (**Campbell, Euston, Stewart, Chapman**) is noted for its emphasis on the impact of nutrition on the health of consumers, developing novel products that can alleviate dietary problems. Research in the SLS is coordinated through the School Research Committee, chaired by the School's Director of Research (**Morris**), and reports to the University's Research and Knowledge Exchange Board chaired by the Pro-Vice Chancellor for Research and Knowledge Exchange.

b. Research strategy

HWU strategy

In 2008, HWU adopted a coordinated and aggressive research intensification strategy. Research was focussed into inter-disciplinary cross-school themes with the Life-Physical Science Interface an example that is particularly relevant to this UoA and which has been central to the rapid expansion of toxicology-related research (specifically the research of **Stone** and **Johnston**). Research across this interface includes cell imaging, using confocal microscopy together with specialists in biophysics and imaging, to analyse GFP-tagged stress signalling proteins in transgenic plants (**Morris),** and the "Lab on a Chip" systems together with **Stone** and collaborators at the Moredun Research Institute, (funded by the EPSRC in a joint project). HWU set a target for recruitment of research-intensive academic staff via our "Global Platform for Research Leaders" which has led to the recruitment of **Stone, Panagiotidis**, **Stewart** and **Speers**). HWU strategy is to enhance the relationship between our research and the relevant industries, of which Brewing & Distilling is the pre-eminent example. In 2012 a HWU-wide postgraduate research studentship scheme was established, the James Watt Scholarships, that awards 50-80 PGRs scholarships per annum, which has contributed to PGR growth associated with this UoA. The HWU Centre for Academic Leadership and Development (CALD) has been established during the assessment period and runs the HWU Crucible, which fosters the development of inter-disciplinarily research especially aimed at ECRs. **Johnston** was supported by the HWU Crucible to investigate bacterial and mammalian cell responses to ingested nanomaterials, in collaboration with Moredun. HWU is also one of the founding members of the Scottish Funding Council's "Interface Food & Drink" (IFD) initiative and the location of one of IFD's technology translators with us in this UoA facilitates some of the research undertaken, particularly in Brewing & Distilling.

SLS strategy

The 2008-2013 strategy was to enhance our position as the pre-eminent university for research in brewing and distilling and to be the leading university in Scotland for food science research, in which aim we have been successful. Our aquaculture-related research mentioned in RAE 2008 now has a stronger emphasis on environmental impact and sustainability of food supply and is now reported in UoA A7 alongside other aquatic research. Over the same period, HWU adopted an aggressive research intensification strategy through which we have attracted the senior researchers at the core of the toxicology research group. There has been significant change in the leadership in SLS since RAE 2008 with the external appointments of a new Head of School

(**Hopkins** recruited from the then Scottish Crop Research Institute in 2011; returned in UoA A7), a new Deputy Head of School and Director of Toxicology Research (**Stone** from 2012), and a new Director of ICBD (**Speers** from 2013), complemented by the internal appointment of a new Director of Research (**Morris** from 2010). The new leadership has led to the recruitment of research-intensive staff since 2010 (11 to SLS as a whole, of which 5 are submitted to this UoA), and the establishment of distinct research groups with devolved budgets for pump-priming of research.

These changes have been accompanied by substantial strengthening of our external collaborations and partnerships. These include the Institute of Occupational Medicine (IOM, with whom we have joint EU FP7 projects, two honorary professors, 1 honorary lecturer and 3 honorary research fellows); the Moredun Research Institute (joint PhD projects, two honorary professors, and wider funded collaborations with the LSI); the Joint Research Centre – European Commission (supervision of 2 commission funded PhD students); the Science & Advice for Scottish Agriculture (SASA; two joint PhD studentships); the Scotch Whisky Research Institute (SWRI; two honorary professors, joint MSc and PhD students), and the James Hutton Institute (formerly the Scottish Crop Research Institute, joint appointment of **Stewart**). We also have a strong and diverse portfolio of industrial support including GSK (GlaxoSmithKline) on macrophage characterisation during inflammation (**Stone,** supervision of GSK staff to complete PhD registered at HWU); MSD (formerly Schering Plough) on vaccines for aquaculture (**Morris**) and Green Biologics Ltd (**Mitchell**), working on innovative sources of biofuels from bacterial fermentations. Research by **Morris** related to brewing and distilling is being supported through the major industry trade association, the Scotch Whisky Association (SWA), as well as Interface Food and Drink (see later).

The success of our strategy is indicated by the following:

- An increase in internationally recognised research outputs (an increase in the average number of peer-reviewed papers per submitted FTE per annum of 75% between 2008 RAE and 2013 REF [2.0 cf. 3.5]).
- An increase in PGRSs from 23 FTE in RAE 2008 to 31 FTE in REF 2013 for this UoA, which represents a more than doubling of the intensity of PGRS training (1.8 PGRS per submitted FTE in 2008 compared to 3.6 PGRS per submitted FTE in 2013).
- We maintain the close industrially-relevant focus for which HWU is renowned (as indicated for example by £272k support to the UoA from the Technology Strategy Board since 2011), and because of the applied nature of some of our research, mechanisms for dissemination extend beyond academic publication to include policy documents and patents that complement outputs listed in RA2.

Toxicology Research

This research commenced in 2010 with the appointment of **Stone**, followed by **Johnston** and **Panagiotidis** in 2011 and 2013, respectively. **Stone** and **Johnston** investigate the human health impacts of engineered nanomaterials [see **Stone** outputs 1, 3; **Johnston** outputs 1-4] in addition to the environmental impacts of nanomaterials [**Stone** outputs 2, 4. Their work also includes development of *in vitro* alternatives for toxicity testing relevant to nanomaterials and other chemicals. Funding for this work comes from the EU (£685k), RCUK (£155k), charities (Colt foundation; £191k) and industry (GSK; £27k). Extensive collaboration exists with the Institute of Occupational Medicine (UK), and both within the UK and internationally. There are also strong research synergies (joint EU projects; £841k) with research on environmental impacts of nanomaterials led by another member of SLS (Fernandes who is reported in UoAA7). **Panagiotidis** investigates (i) molecular mechanisms underlying the pathophysiology of human disease [output 4]; (ii) molecular therapeutics and biomarker development [output 3] and (iii) the role of natural products in health and disease [outputs 1, 2]. He has productive and continuing collaborations with Democritus University of Thrace, University of Patras, and National Technical University of Athens, Surrey University (UK) and the Redox Biology Centre, University of Nebraska-Lincoln (USA). His international collaborative work concerns the underlying mechanisms of human disease pathophysiology and on the role of novel natural products from Greek endemic species in health and disease as well as biomarker development descriptive of the biological effects of radiofrequency electromagnetic waves.

Brewing & Distilling Research

ICBD research is informed by the ICBD industrial advisory board (including senior members of the world's largest brewing and distilling companies) and is facilitated by our pilot-scale plant for brewing and distilling, unique to the UK HEI sector. Brewing & Distilling research spans fundamental aspects of the biology of the raw materials (yeast and barley) including aspects of their production and physiology, and has been supported for many years by strategic associations with trade associations such as the SWA and companies such as Suntory and Diageo. **Speers** has built on existing collaborations with scientists at the Canadian Grain Commission and the University of Saskatoon's Crop Development Centre, to improve the fermentability of malted barley [output 1]. This research has resulted in development of fermentation modelling software and an insight into barley malt fermentability. His work has also resulted in development of an industry standard method. This method is designed to detect and help prevent the occurrence of premature yeast flocculation, and is estimated to save $10M per annum in the Canadian industry during years when malting barley is infested with fungal pathogens (estimated to be every three years). The ASBC Yeast-14 method is also being used to monitor malt fermentability and brewing yeast behaviour [output 4]. **Hughes'** research explores beer quality and monitoring, including the development of a membrane that becomes proton-porous on exposure to ionophores (such as hop bitter compounds) and has potential application in the screening of new drug candidates. He has also recently completed a book entitled "Science and Commerce of Whisky" that is set to be the premier technical text on whisky. Working with **Euston**, **Hughes** has been investigating the ligand-protein interactions of proteins in order to understand how ligands influence the unfolding and denaturation of proteins at interfaces. With colleagues from engineering, and with the expertise in protein chemistry of **Euston** and **Campbell** (see below), he is also working on SFC- and Mars UK-funded research (£400k) to valorise waste streams from breweries and distilleries. Some of this work has led to the development of a spin-out business plan that is currently one of the 10 Converge Challenge finalists (see later). He has also recently won a £180k KTP award for work with Spencerfield Spirits. **Mitchell** has utilised his expertise in microbiology and molecular biology to develop novel rapid methods for the identification of spoilage organisms in breweries, with support from the Institute of Brewing and Distilling [output 3]. Work by **Morris** with current grant support from the SWA (£185 k) has focused on the physiology of plant biotic and abiotic stress tolerance in plants [output 2]. He has used the model plant *Arabidopsis* to show how signal transduction pathways modulate the plant response to biotic and abiotic stress [output 1] and is now translating this across to barley, including experimental malting barley lines that are genetically modified for salt stress tolerance or fungal pathogens [output 3].

Food & Nutrition Research

This research concentrates on the molecular dynamics of fats and proteins in natural and manufactured foods (**Euston** and **Campbell**) and the application of high-throughput LC-MS and GC-MS metabolomics applied to food quality, safety and functionality (**Stewart**). Euston has built on industrial (e.g. Michaels Foods, Fonterra NZ) and academic collaborations with grant support from EPSRC and TSB (£272k) to undertake fundamental physicochemical studies on the functional properties such as emulsification, foaming and water binding (thickening) of food proteins that have established the importance of protein structure to function in foods [outputs 1-4]. **Campbell** undertakes research on thermal denaturation and glycation and the effects these have on the functional properties such as emulsification of food proteins. Two patents resulting from this work has been licensed to two leading international food ingredient companies ((US716316B2 to Rovita GmbH and GB1204160.4 to Tate & Lyle). The research of both **Euston** and **Campbell** benefits from close links with the SME Nandi Proteins Ltd (HWU spin-out company established by **Campbell**), and exploits the study of protein functionality from the molecular level, through bench scale trials to commercial exploitation of novel protein ingredients, especially as fat replacers. For example a modified whey protein product, Roviprod 60MP, is currently being commercially produced and supplied as a fat replacer in yoghurts and cheese. The amino acid tryptophan is an essential component of a healthy human diet, however errors in tryptophan metabolism can result in cataracts or dementia and other pathological conditions, thus **Chapman's** work on the mechanisms of tryptophan regulation [outputs 1, 2] has important implications for human health. **Stewart's** research using state-of-the-art metabolomics approaches enables reporting on

hundreds of compounds simultaneously (with funding from charities, the Scottish Government, EU, LINK and industry such as Unilever, GSK) and has provided evidence for polyphenolic components in soft fruits exerting potent pharmacological activity [outputs 1-4] with implications for degenerative diseases such as cardiovascular disease, cancers, and Alzheimer's. Many aspects of this work have since been exploited in collaboration with GSK, Mylnefield Research Services and the James Hutton Institute to deliver soft fruit varieties with enhanced levels of polyphenolics (www.mrsltd.com/berries.asp). In addition, **Stewart** is part of a LINK consortium together with IBERS Aberystwyth, Harper Adams College and an industrial consortium including GB Seeds and Dupont developing genetic improvements to oat, targeting in particular beta-glucan for human health benefits.

c. People

Staffing strategy and staff development

Given HWU's research intensification strategy and the need to inject new leadership following retirements since RAE 2008, there has been a strong emphasis on recruitment on senior academics (**Stone, Speers, Stewart, Chapman** & **Panagiotidis**) in recent years. These have been accompanied by the ECR appointment (**Johnston**) to complement established and mid-career researchers (e.g. **Hughes**, **Euston**, **Mitchell**, **Morris** & **Campbell**). Our recent recruitment has led to a team with significant new experience and leadership capacity (5.0 FTE professors out a total 9.5 FTE) and well balanced in terms expertise (3.8 FTE with biological expertise in toxicology, health and nutrition; 3.5 FTE with expertise in food science; and 2.2 FTE with expertise in analytical chemistry), age (1.0 FTE between 30 and 39 years, 2.8 FTE between 40 and 49 years, 4.7 FTE between 50 and 59 years, and 1 FTE of 60+ years. The gender balance is 2.3 FTE female and 7.2 FTE male, recognizing a larger proportion of part-time working amongst the females for family reasons. The strategy is to recruit academic staff on the basis of research achievement, or potential in the case of ECRs. The HWU Global Platform for Research Leaders is an on-going process and is an explicit element of the HWU 2013-18 Strategic Plan. As a consequence, in this area of research we plan to double the number of research academic staff, and for this to be accompanied by proportionate growth in the number of PDRAs and PGRSs. Suitable individuals across all levels of the academic career are being sought to replace staff lost by natural turnover and to enhance critical mass of research active staff whilst retaining a balanced (in terms of age, gender and expertise) and sustainable staff structure (SLS overall has a female to male ratio of 0.65). In doing this we have aimed to improve our existing areas of strength and to launch novel areas that will become a major facet of the research agenda for the future.

HWU has recently been awarded Athena SWAN Institutional Bronze Status for all its STEM departments. We have a robust framework to support equality and diversity including an action plan to further embed the Athena SWAN principles and effect continued culture change, including an improvement in the gender balance of academic staff. A University-wide Equality and Diversity Advisory Group oversees and advises on operational and legal compliance and ensures effective linkages across the University's governance structures. The positive actions that HWU has taken to support the career development of all researchers and the measures in place to implement its declared principles have been recognized externally. In 2010, it was amongst the first 10 HEIs in the UK to receive the "HR Excellence in Research" award from the European Commission. This was re-awarded against a renewed action plan in January 2013.

ECRs are supported by the wide range of "Research Futures" courses offered by HWU's CALD, including the Postgraduate Certificate in Academic Practice, which covers developing key research skills, and the HWU Crucible (mentioned above). Also available is the opportunity to compete in the Converge Challenge, which supports the development of interdisciplinary projects and commercially-focussed research (see REF3a). HWU's personal development review system helps ECRs set research objectives. PDRAs are full members of the School's management structure and are represented through elected representatives on the SLS Management Committee. All PDRAs and PGRs are encouraged and supported financially to attend and present at conferences and take part in events for public outreach (e.g. HWU "Brightest Watts" summer school).

Research students

Since RAE2008 the number of PGRS associated with this UoA has increased from 23 to 31FTE. Research students are provided with a tiered approach to training and development. The supervisory team oversees the subject specific training and ensures that health and safety training

is appropriately carried out. The School of Life Sciences is responsible for progress monitoring, which is co-ordinated by the Director of Postgraduate Research Studies and supported by the School's Director of Research. The School is also responsible for mentoring of research students in areas supplementary to that provided by the project supervisors, for example training in giving presentations or in grant applications. All research students have full access to all of the facilities of the School (for example biochemical analytical facilities) and access to facilities elsewhere in the University is routinely arranged. They all have a dedicated desk and networked PC (unshared) in shared offices. PGRSs (and ECRs) are also encouraged to develop research skills through the Research Futures Programme provided by the CALD. This includes training in organisation skills (e.g. time management), literature survey, report writing, IT, team and project management, oral presentation, career development, research ethics, business awareness and intellectual property issues, which is complemented by subject specific opportunities. The mutual obligations and responsibilities of research students, supervisors and the University are formalised in the University's PGRS Code of Practice, which fully takes into account the requirements of the RCUK Concordat. The University's £9M Postgraduate Centre (opened 2010 with RCUK-SRIF and industrial support) provides and innovative approach to PGRS development and houses an auditorium, seminar, study and social spaces, and video-conferencing facilities for PGRSs.

d. Income, infrastructure and facilities

Income

Total external research income has grown from £260k/year during the RAE2008 assessment period to £350k per year for REF2014, an increase of 35%. This is associated with the vigorous research strategy and is consistent with the increase in PGRSs and peer-reviewed outputs. The external grant income is accompanied by HWU investment to the value of £430k to established toxicology research, £78k from SFC's IFD initiative, and £480k on laboratory refurbishments from the HWU capital projects budget to support Food & Nutrition research. Brewing and Distilling research has been supported by industrial scholarships from Diageo for PGRS training, and a recent bequest of £70k to upgrade facilities.

Infrastructure and research support

Research in SLS is supported by 5.5 FTE designated research technicians, including an Animal Care and Welfare Officer and additionally there is access to a staffed (1.0 FTE) Life Sciences workshop, a Facilities Manager (1.0 FTE) Stores staff (1.5 FTE), and IT support (1.0 FTE). Most administrative support is provided at the SLS level with the share for this UoA equating 2.0 FTE, and there is a dedicated research administrator (0.4 FTE). In addition, one of the SFC's IFD technology translators is located at HWU providing the equivalent of 0.25 FTE support to this group, and there is a 1.0 FTE Business Development Executive shared between SLS and the LSI. The Toxicology group includes a Senior Research Fellow, whose current funding makes him ineligible for inclusion as a PI, who serves as the laboratory manager for the group and a key supervisor of undergraduate and postgraduate students during laboratory based projects.

HWU Research and Enterprises Services (RES) provides professional support on all aspects of bid development and commercialization of the research outcomes including the creation of new companies and engagement with existing companies. The particular focus has been on growing engagement with the commercial sector. Since 2011 all of the PGRS workspace has been refurbished to provide modern, shared office space in which each student has a dedicated desk and PC, with internet, telephone and printing access. All PDRAs are accommodated in shared offices (2 per office) with equivalent network and communications facilities.

Facilities

We are unique in the UK in benefiting from large-scale pilot plant for malting, mashing, brewing and distilling, as well as a refurbished sensory suite, which facilitates the organoleptic assessment of beers and spirits. For biochemical analysis we have a dedicated analytical laboratory with GC-MS, LC-MS (with Quadropole tandem MS), HPLC and technical support. Protein purification and analysis is underpinned by multiple FPLC units, 2D gel equipment, a fluorescent gel scanner and MALDI-ToF. Cell and molecular biology is made possible by laminar flow hoods, culture cabinets, a flow cytometer, FACs Array, confocal microscope, Comet assay facilities and dynamic light scattering. In addition we have access through reciprocal arrangements to advanced analytical

facilities at the Moredun Research Institute (proteomics), the James Hutton Institute (biochemical analysis) and the Scotch Whisky Research Institute (flavour analysis, olfactory GC-MS). Molecular biological work is provided for by the appropriate electrophoresis and documentation systems as well as multiple qPCR systems. Our work on GM barley is facilitated by a Biolistics apparatus, dedicated growth rooms and tissue culture cabinets.

Policy and Practise for Research Governance
HWU has a Code of Good Practice in Research, adherence to which is closely monitored. Research in the SLS is coordinated through the School Research Committee, chaired by the School's Director of Research (**Morris**), and reports to HWU's Research and Knowledge Exchange Board chaired by the Deputy Principal for Research. SLS operates an Ethics Committee and is fully compliant with the Home Office Animal Procedures Act. The Biological Safety and Genetic Manipulation Safety Committee reports to the HWU's Health and Safety Committee (chaired by the Head of SLS, **Hopkins**), there are dedicated Biological and Radiation Safety Officers. HWU's Code of Practice for PGRS students and supervisors covers the mandatory progress monitoring procedures for students and the evaluation and training of supervisors. PGRS progression is formally managed by a dedicated PGRS co-ordinator at the SLS level, who is also a member of the SLS Research Committee.

e. Collaboration or contribution to the discipline or research base

Collaborations: Collaborative research is at the heart of everything that we do. This occurs within and across disciplines both within and outside of HWU in order to bring in research expertise from both biology and cross-disciplinary subjects such as chemistry or engineering. The HWU research themes (LSI) and Crucible have boosted collaboration with other HWU Schools, particularly with the School of Engineering and Physical Sciences, where we have joint research projects and PhD students (**Stone, Euston, Morris**). Outside of HWU, our UK HEI collaborative partners include the Universities of Edinburgh, Liverpool, Birmingham, Nottingham, Cambridge, Manchester, Leeds, Bristol, Exeter and Kings College London. Industrial collaboration is a very important component of our research strategy as exemplified by the text in section B and data in section D, and by REF3a. Our industrial collaborators include industry bodies such as Interface Food and Drink, and also the Scotch Whisky Association, as well as leading individual companies such as MSD (previously Schering Plough), Green Biologics, Diageo, Conacyt, Suntory and Nikka Whisky (Japan), Institute of Occupational Medicine and GlaxoSmithKline. The recruitment of new staff with a strong track record of international collaboration (**Stone, Stewart**) has markedly helped raise the profile of collaborative research within SLS.

Overseas collaborators are increasingly important, especially in the context of EU grant support, and functions to enhance our pool of research expertise both within the area of biology and across the disciplines. Notable international collaborators include: CSEM (Switzerland); the Helmholtz Zentrum München, Fraunhofer-Gesellschaft Zur Förderung der Angewandte Forschung, Heinrich Heine Universität, Institut für umweltmedizinische Forschung (Germany); Aarhus Universitet, University of Copenhagen (Denmark); CNRS-INRA Evry, Université Paris Diderot, (France), Katholieke Universiteit Leuven, Vrije Universiteit Brussel, (Belgium); Rijksinstituut voor Volksgezondheid en Milieu (Netherlands); University of Rochester, Rice University, Clemson University (USA); University of Saskatchewan, the Canadian Grain Commission (Canada) and the Shanghai Institute of Biological Sciences (China).

The commitment by our staff to promoting the research standing of the discipline is exemplified by **editorships or editorial board memberships** on a number of leading journals, for example: FEMS Microbiology Letters (**Mitchell**), American Journal of Food & Nutrition, Pharmacology and Therapeutics, Journal of Biochemical Technology, Cancer Letters, International Journal of Experimental Pathology, Annals of Nutrition & Metabolism, Toxicology Letters, Toxicological & Environmental Chemistry (**Panagiotidis**); Food Research International, Tech. Quarterly, MBAA (**Speers**); American Journal of Advanced Food Science and Technology, Cellulose Chemistry and Technology, The Open Food Science Journal, Journal of Berry Research (**Stewart**); Nanotoxicology (**Stone**).

Staff are also very active within their own research specialisms with an array of **invited and keynote addresses** at national and international research conferences including **Johnston**: European Environment Agency, Copenhagen 2011; German Federal Institute for Risk Assessment Berlin 2012, **Mitchell**: Keynote speaker, 12th International Workshop on the Regulation of Metabolism, Genetics and Development of the Solvent- and Acid-forming Clostridia; Nottingham, UK (Sep 2012); Invited speaker, ClostNet Conference ; Nottingham, UK (Mar 2013). **Speers**: 6th Canadian Barley Symposium, Saskatoon, July 2010; Plant Canada 2011, Nova Scotia. July 2011; Post-Harvest Management and Technology for Food Security, Jimma, Ethiopia May 2012.
Stewart: Nordic Wild Berry Seminar, Oulu, Finland, November 2008; 3 invited talks, 4th International Conference on Polyphenols and Health, Harrowgate, December 2009; Euro Food Chem XV. Food for the Future, Copenhagen, Denmark, July 20093 invited talks, 28th International Horticultural Congress, Lisbon, Portugal, August 2010; CropWorld, ExCel London Oct 2011; Developing Health Improving Products, Food and Innovation Service, Edinburgh, Sept 2011.
Stone: AAAS Boston Feb 2008; Biochemical Society London Jan 2009; CELLTOX Rome Oct 2011; Nanotoxicology Beijing Sept 2012; Nanosafety School Venice 2011, 2012 and 2013.

Researchers' individual expertise has also led to invitations to join UK and international **advisory panels and groups**, for example **Euston** is an Overseas Expert Member of the Irish Dept. of Agriculture Food Institutional Research Measure (FIRM & FIRM+) Funding Evaluation Panel, 2011 (equivalent to DEFRA-LINK or TSB funding). **Panagiotidis** is a Scientific Advisory Board Member for the International Institute of Anticancer Research (IIAR), Athens, Greece. **Mitchell** is a Member of the Executive Board and Member of the Executive Management Committee, European Federation of Biotechnology. **Johnston** is a visiting lecture at Cranfield University and a former member of the UK Government Nanotechnology Research Strategy Group. **Stewart** is on a number of influential committees, including the JHI Management Board and Science Development Committee, and is an Invited Fellow, Royal Society of Chemistry. He is also a member of the European Food Safety Authority – GMO Panel, Food and Feed Working Group (2010-2011). He is a Core Member of BBSRC Research Committee B (Plants, microbes, food and sustainability) 2011-present and a Core Member of the BBSRC Follow-on Funding Committee 2011-present. He is also a member of the International Review Committee for Danone Fruit and Drink R&D 2008-present.

Stone provides expert advice to the Royal Commission and to the Royal Society/Royal Academy of Engineers on human and environmental hazards of nanomaterials, and is member of the working group to prepare WHO Guidelines on Protecting Workers from Potential Risks of Manufactured Nanomaterials. She is Chair of the working group and executive group for International Life Sciences Initiative (ILSI) project NanoRelease, focused on release of nanomaterials from food and absorption into body and an invited expert to ILSI Nanocharacter project on defining a roadmap to allow characterisation of nanomaterials for research and regulation. She is also an OECD representative for UK (Defra) to the Working Party on Manufactured Nanomaterials (WPMN) – Steering Group 7 and on the Executive committee member of the International Council on Nanotechnology (ICON) 2007-2010).