Institution: University of Sussex

Unit of Assessment: UoA 5 Biological Sciences

1. OVERVIEW

The UoA5 submission comprises groups from the School of Life Sciences and the Brighton and Sussex Medical School (BSMS).

Research in the School of Life Sciences is organised into five Subject Groups: Biochemistry and Biomedicine (13 FTE); Chemistry (13 FTE); Evolution, Behaviour and Environment (16 FTE); Genome Damage and Stability (19 FTE); Neuroscience (12 FTE). The Chemistry Subject Group is making a separate submission to UoA8. The Medical School staff included in the submission (10 FTE) represent a range of research activities that align with the Life Sciences Subject Groups and, in many cases, maintain close collaborative links with them.

The new Life Sciences building, to be occupied in 2016, will bring all of the Subject Groups from the School of Life Sciences (including the Chemistry staff submitted in UoA8) and the cognate research groups from the BSMS into a single location, alongside a number of neuropharmacology research groups from the School of Psychology (submitted under UoA4). This co-localisation of basic and translational research groups, spanning the molecular to the behavioural, will cement the considerable synergies that already exist between different research groups at Sussex, and provide an exciting multidisciplinary environment that will foster research of international standing.

2. OUR RESEARCH STRATEGY AND ITS OUTCOMES

'To sustain a breadth of high-quality biological science research, from molecule to system, focused in explicit "Centres of Excellence" and with a clear and operational commitment to translational opportunities across all our research activities'.

This research strategy, developed over the four years since Professor Laurence Pearl FRS was appointed as Head of the School of Life Sciences, is based upon three main watch-words: Excellence, Collaboration and Sustainability.

Excellence We pursue excellence in basic and translational science, with a strong focus on addressing 'central' questions in biology and translating basic insights into broad socio-economic impact via, for example, new approaches to a sustainable biosphere, and new diagnostics and therapies for major human diseases. While fully cognisant of the changing strategic priorities of funding bodies, and sufficiently flexible to take best advantage of these where appropriate, our research is unapologetically curiosity-driven, and dictated by the fundamental importance of the questions we ask, and the solutions our answers provide. We are firmly committed to the notion that excellence will always find funding.

Collaboration We recognise that our resources are limited and that it is not realistic to attempt to achieve the level of excellence to which we aspire across the full spectrum of the biological sciences. Our research strategy, therefore, seeks to achieve focus in terms of a defined and coherent set of research areas into which our resources can be directed, coupled with a strong interdisciplinarity in terms of the breadth of technical approaches we can deploy. The success of this is highly dependent on a strong ethos of collaboration and cooperation between researchers across the Subject Groups and beyond, and the maintenance and further development of this is a major component in our research strategy.

Sustainability We make an unequivocal commitment to the sustainability of the physical research environment, and above all to the careers of the researchers themselves, as the essential foundations of the research excellence to which we aspire and the focused interdisciplinarity needed to achieve it. Our research strategy places great emphasis on providing and maintaining facilities and services for common research needs such as cell culture, mass spectrometry, X-ray crystallography, bioinformatics, and advanced microscopy, etc. These are managed by technical specialists who provide teaching and training to students and research staff, and responsive and collaborative access to the best equipment we are able to provide. Central to the sustainability of our research is the

development of a career structure that looks after the superb cadre of independent Research Fellows we have been able to attract, and provides them with support, mentoring and a clear pathway to permanent appointment on the basis of their research excellence.

Significant Changes Prior to 2009, the School of Life Sciences' research strategy was based upon a perceived need to maintain balance across the full breadth of research interests. While this certainly facilitated the delivery of a broad portfolio of taught programmes at undergraduate and postgraduate level, and delivered a reasonable research profile overall, it had the potential to generate a rather atomised research culture in parts of the School, such that collaboration and focused interdisciplinarity were difficult to achieve. Furthermore it carried the risk of feather-bedding a clutch of weak researchers who were justified as 'placeholders' for areas of interest that were considered essential to the broad taught offering.

Most importantly, this approach frustrated attempts to develop focused critical mass, and effectively capped the growth of successful internationally outstanding research concentrations in Genome Damage and Stability and in Neurosciences, for example.

A new approach to research strategy was instigated in 2009, when the School of Life Sciences was subjected to a substantial financial restructuring, and Prof. Laurence Pearl FRS was appointed as Head of School, bringing in, above all, a high-level commitment to research excellence and sustainability. As part of the implementation of this new research strategy, the most significant change to the structure of the School was the removal of the legacy of Departmental divisions and its replacement by a unified structure in which teaching and postgraduate training are co-ordinated centrally at School level, while research areas are represented by Subject Groups. This research-focused structure is designed to support the main strategic aims of excellence, collaboration and sustainability, to facilitate the strategic planning of shared equipment and facilities, and areas for recruitment and capacity-building, and to encourage a co-operative dialogue amongst and between coherent research *foci*.

The Subject Groups are chaired by leading researchers in their fields:

- Biochemistry and Biomedicine: Prof. Alison Sinclair
- Chemistry: Prof. Geoff Cloke FRS (UoA8)
- Evolution, Behaviour and Environment: Prof. Jeremy Field
- Genome Damage and Stability: Prof. Keith Caldecott FMedSci
- Neuroscience: Prof. Guy Richardson FRS

Subject Chairs work very closely with the Head of School to develop plans for their individual group, and are *ex officio* members of the Management Committee, playing direct roles in the development of the overall research strategy at School level. As well as giving general leadership to the researchers within their groups, Subject Chairs provide mentoring to newly appointed and early-stage researchers, and undertake the formal appraisals of faculty and other research staff in their Subject Groups. Further details of the activities of the Subject Groups are given below.

The new research strategy, and the structural changes needed to implement it, have had some very positive and tangible outcomes since it was fully implemented in 2010.

The reorganisation into two separate Subject Groups – Evolution, Behaviour and Environment, and Neuroscience – of researchers previously lumped together as the Biology Department, has allowed their distinctive research strategies to emerge. The focused research excellence embodied by these groups has thus become far more visible to the wider research community, enabling us to make some outstanding new senior appointments into these Subject Groups (see below).

The emphasis on excellence and focused interdisciplinarity has allowed the internationally outstanding MRC Genome Damage and Stability Centre (GDSC) to continue to grow, with the recruitment of new Independent Research Fellows, the award of multiple new Senior Fellowships and Programme Grants, and the establishment of joint translational research facilities with the BSMS. The GDSC is a joint venture between the University and the Medical Research Council, and is in receipt of a Centre Grant from the MRC that supports the infrastructure and provision of shared facilities and resources, and is an integral component of the Barts/Brighton Experimental Cancer Medicine Centre (ECMC). As an MRC Centre, the GDSC has a Director (Prof. Tony Carr) who is responsible for the scientific

management of the research programmes the Centre accommodates, while Prof. Keith Caldecott has the role of Chair of the Genome Stability Subject Group, providing the formal link between the GDSC and the overall School management structure. This role was held by Prof. Alan Lehmann FRS during the first part of the reporting period.

The breakdown of the Departmental structure and the new emphasis on research collaboration have encouraged a far more outward-looking approach and have led to the development of a new cross-campus initiative – Sussex Neuroscience. This initiative brings together the Neuroscience Subject Group in Life Sciences with researchers in other Schools and/or Units of Assessment – Psychology, Informatics and the Medical School – to develop joint research projects and doctoral training programmes. Sussex has great strengths across all aspects of the neurosciences, but had not previously developed them as a coherent whole. A similar initiative – Sussex Biomedicine – bringing together biomedical and clinical-laboratory research across the University and the Medical School, is in the early stages of planning.

The emphasis on excellence in basic *and* translational research, and our focused interdisciplinarity, underpin the development of the Translational Drug Discovery Group (TDDG). This multidisciplinary activity, based in the Biochemistry and Biomedicine, and the Chemistry Subject Groups, was set up, with a substantial investment by the University, explicitly to discover new small-molecule drugs primarily for the treatment of cancer and neurological, neurodegenerative and psychiatric diseases, develop them through proof-of-concept, and deliver them into early-stage clinical trials in collaboration with commercial biotechnology and pharmaceutical industries. The TDDG is led jointly by Prof. Simon Ward (submitted in UoA8) and Prof. John Atack, who were recruited to Sussex in 2011 and 2012 from highly successful industrial research leadership roles in GlaxoSmithKline and Janssen Pharmaceutica respectively. In contrast to similar endeavours in other institutions, the Sussex TDDG is fully embedded in the academic structure of the University and interfaces directly with high-quality research activity in Neurosciences and Genome Stability, driving projects through multidisciplinary project teams encompassing all aspects of the drug discovery pipeline. Within the first two years, the group has already attracted over £6m in external research support, and is the academic cornerstone of new MChem and MSc degrees in Chemistry and Drug Discovery, spanning the UoA5–UoA8 border. The formation of the TDDG is a direct response to the absence of co-ordinated initiatives and priorities for the discovery of new medicines and the failure of what was previously seen as a commercial imperative – to deliver.

The re-emergence of Neuroscience as a distinct Subject Group in its own right within the School has facilitated the development of the Cell and Molecular Neuroscience Centre – a new Centre of Excellence and focused interdisciplinarity based on the very successful model of the MRC Genome Damage and Stability Centre at Sussex. The Centre is directed by Prof. Leon Lagnado, recently recruited from the Medical Research Council Laboratory of Molecular Biology (MRC-LMB) in Cambridge, who has also taken on the role of Director of the cross-School (and UoA) 'Sussex Neuroscience'. Three additional faculty positions have been made available to Prof. Lagnado to further strengthen research activities in Sensory Neuroscience – one offer is pending, and two further posts will be advertised in 2014. The Centre, consisting of 18 research groups from the Schools of Life Sciences and Psychology when fully staffed, is housed in the existing CRPC building at Sussex, which has been substantially refurbished for the purpose at a cost of ~£1.5m, and re-badged as the 'Neuron'. The Centre will relocate to the new Life Sciences building on its completion in 2016. Research in the Centre covers sensory neuroscience, memory and learning, neuronal function and dysfunction, neuronal development, and neuropharmacology and addiction, and is supported by state-of-the-art facilities for electrophysiology, live-cell and tissue imaging, and the genetic manipulation of insects, zebrafish and mice.

Within the Evolution, Behaviour and Environment Subject Group, we have built a major interdisciplinary focus of expertise in social insect biology, with outstanding appointments in the REF period (Ratnieks, Hughes, Goulson) adding to existing strengths (Field, Collett, Graham). This grouping is almost unrivalled internationally in terms both of productivity and of scientific influence in its field, with a combined h-index of around 180 from more than 20 research publications in *Nature and Science.* A recent analysis (*Lab Times* 2012, 3: 34–6) of European animal-behaviour research found Ratnieks to be not only the most-cited researcher studying social insects, but also the most-cited UK researcher on animal behaviour in general outside Oxbridge. Social insect research in the School integrates studies

of evolution, behaviour, conservation and neuroscience in this economically and biologically key group of organisms.

3. PEOPLE

Implementing The Strategy*:* Our research plan and approach to implementation reflect our high-level strategy of sustaining a suitable breadth of high-quality research activity from molecule to system, with explicit 'Centres of Excellence' in Genome Damage and Stability, Social Insects, Neurosciences, and Drug Discovery, and with a clear and operational commitment to translational opportunities across all our research activities. Research breadth is important but, with the limited resources of a smaller University, this must be tempered by an absolute insistence on research quality – we cannot do everything, but what we do we must do exceptionally well. Central to research excellence are the people who do the research and the infrastructure within which they operate – maximising the quality and effectiveness of these two strands is the key to implementing our research strategy and forms the core of our forward research plans.

People: Sustaining and developing our research portfolio at the level to which we aspire requires a body of researchers whose individual research excellence is recognised and valued, but who can also operate effectively as a community and in larger multidisciplinary teams, as required.

The Subject Group structure, with its research-based definition, has been instrumental in building a sense of identity and community amongst existing researchers who were previously divided from each other by Departmental considerations. Subject Groups are porous both within the School and across School boundaries, facilitating productive interdisciplinary engagement with colleagues in other parts of the University. The Subject Group structure also provides an effective framework for identifying new research opportunities or technical areas where capacity-building is needed, and for driving staff development and recruitment accordingly.

Our Career Progression 'Pipeline': The recruitment and retention of the highly effective researchers we need to fulfil our research aspirations requires an uncompromising commitment to recognising and rewarding success, and a transparent career-development process that enables researchers to fulfil their potential.

We recognise how difficult it is for a newly appointed junior Lecturer to establish sustainable independent research activity in a UK university, with the competing commitments of teaching and administration, and the limited and short-term resources available through the project-grant system. Success is especially difficult where caring or family responsibilities are also involved, and this is clearly reflected in the small numbers of women who apply for such posts, and the high attrition and poor career progression they subsequently experience. Consequently such traditional 'entry-level' appointments now play a very limited role in our Faculty recruitment policy.

Instead, we focus our early-career recruitment on attracting high-quality independent Research Fellows who are able to join the School with programme-level funding, and provide them with a clearly defined mentoring and career-development path. Holders of Senior Fellowships from UK research councils or charities (including the 3-year extension phase of Royal Society University Research Fellowships), are considered to be 'tenure-track'. They are thus eligible to apply for permanent appointment at the level of Reader or above, which is judged transparently by a committee chaired by an external expert before the end of their fellowship. Researchers submitted in UoA5 who have come, or are coming, through this route include Dr Eva Hoffmann, Dr Michelle West, Prof. Mark O'Driscoll, Prof. Juan-Pablo Couso, Dr Matthew Neale, Dr Edward Morrow, Dr Jeremy Niven, Dr Jonathan Baxter, Dr Helfrid Hochegger, Dr Hideo Tsubuchi and Dr Steven Sweet. Recruitment via this route is inevitably opportunistic, and depends on the individual Fellow choosing us as the best place in which to build and develop their research career. However, that the Fellows 'vote with their feet' by coming here reflects the perceived strength of our research in their field, and directly bolsters the foci of excellence we seek to foster in our strategy. We consider it a strong vote of confidence in the vitality of our research activities, and the appeal of the environment and career development we offer, that we are able to attract and retain this excellent cadre of independent Fellows, and to develop them as our future senior Faculty.

Direct Faculty Recruitment: Opportunities to recruit directly to permanent positions at senior level arise from additional posts made available either as part of new developments such as the Translational Drug

Discovery initiative, or through a strategy of proactive replacement appointments resulting from the retirement or relocation of existing Faculty members. As part of the appraisal process, we identify senior researchers who may be 'at risk' of recruitment by other institutions, or who may be thinking of retiring. Where the departure of a colleague to another institution is considered to be deleterious to our research strength, the University is usually able to offer the appropriate inducements to retain the individual concerned; however, it is recognised that mobility is an essential part of academia. Where a colleague is intending to retire from active research, we negotiate a timely run-down that minimises the impact on the overall research profile, and allows a timely proleptic appointment to be made where appropriate. The ending of a statutory retirement age has made succession-planning a more complex process but, with careful discussions with more senior colleagues, we have been able to engineer effective succession plans in a number of key research areas, whereby the 'baton' can be passed on with minimal loss of research power.

Whether by retirement or departure, the prospective recruitment opportunity is actively discussed at School (and sometimes University) level and an appropriate recruitment process is defined in accordance with the high-level strategy of maintaining research breadth while building on foci of excellence that can benefit from interdisciplinarity and collaboration.

We have been able to make some outstanding senior appointments in support of this strategy:

Prof. John Atack and Prof. Simon Ward (UoA8) were recruited from Janssen Pharmaceuticals and GSK respectively to jointly lead the new Translational Drug Discovery Group established at Sussex with >£2m of seed funding. Both have excellent track records of drug discovery in the pharmaceutical industry, and have established a highly structured activity at Sussex that is tightly integrated with the leading basic and translational biomedical research foci in the University and has attracted >£6m additional research funding (including two Wellcome Trust SDDI Programmes) since 2010. The TDDG aims to deliver drugs into the clinic in areas such as cancer and neurological and psychiatric disease, where there is significant basic research expertise in the University.

Dr Jörn Scharlemann was recruited from the United Nations Environment Programme (UNEP) World Conservation Monitoring Centre, Cambridge, where he was the Senior Scientist directing their biodiversity research programme. Dr Scharlemann's expertise is in biodiversity modelling and resource management, and he was recruited to promote the development of a modern global approach to ecology and biological sustainability in the School, and to lead a cross-School initiative in sustainability involving colleagues from the School of Global Studies, the Institute of Developmental Studies and the Science Policy Research Unit.

Professors William Hughes and David Goulson FRSE were recruited from the Universities of Leeds and Stirling respectively to add to the existing research strengths in social insect ecology and evolutionary biology represented by Jeremy Field, Francis Ratnieks, Tom Collet, Paul Graham and Jonathan Bacon. Hughes brings a strong programme in the evolutionary biology of sociality, symbiosis and sex, with a particular interest in how cooperation evolves and why it is maintained in the face of the apparent advantages that can be obtained by cheating. Goulson's research is concerned with the evolution and conservation of biodiversity – and particularly of bumblebees – utilising molecular techniques to answer ecological questions. Prof. Goulson was amongst the first to recognise the effects of neonicotinoid pesticides on bumblebee behaviour and viability, and is noted for his contributions to 'citizen science' and community engagement.

Professor Leon Lagnado was recruited from the MRC Laboratory of Molecular Biology in Cambridge to head the new Cell and Molecular Neuroscience Centre and direct the cross-School 'Sussex Neuroscience' initiative, which brings together the diverse neuroscience activities of over 40 PIs from the Schools of Life Sciences, Psychology, and Informatics and the Brighton and Sussex Medical School. Prof. Lagnado's own research is in sensory neuroscience and focuses particularly on understanding how synapses in the retina extract and transfer the information in a visual stimulus to the brain.

Attracting International Fellows: Our international reputation in our areas of research excellence attracts high-flying young Postdoctoral researchers from around the world to join our research laboratories via a range of International Fellowships. More than 15 such International Fellows have worked with us in the last three years, supported by bodies and schemes such as Marie Curie, Human Frontiers, the Swiss National Science Foundation, the Fyssen Foundation, the Alberta Heritage Foundation, the Fundacion Areces, the Higher Education Commission of Pakistan, the European

Molecular Biology Organisation, and the Royal Society Newton Fellowships.

Supporting Successful Research Careers: We provide a comprehensive appraisal and career-management process for research staff at all career stages. Postdoctoral research staff are appraised by the head of the laboratory in which they work, while senior researchers are appraised by their Subject Group Chair, who is, in turn, appraised by the Head of School. Where a senior researcher is at a transition in his or her career, indicated by significant success (or, very rarely, failure), the Head of School and Subject Chair undertake a joint appraisal. We are very aware that, in contrast to their male colleagues, female researchers are less self-promoting and are often reluctant to put themselves forward. A proper appraisal therefore plays a particularly important role in the career-development of women scientists, and its success is evidenced by three of the six promotions to the rank of Professor and two of the four Reader promotions since 2009 having been women (Elizabeth Hill, submitted in UoA8, Louise Serpell, Alison Sinclair, Michelle West and Johanne Murray).

Female researchers often have career breaks and/or extended periods of part-time working, and have a high likelihood of remaining on repeated fixed-term contracts, all of which are to the detriment of their careers. We have been proactive in facilitating the return of women to research by engaging with schemes such as the Daphne Jackson Fellowships, both as a host and as a subsequent employer (Frances Pearl, submitted in UoA8), and by facilitating the transfer of female researchers on part-time/fixed-term posts into full-time permanent positions (Ildiko Kemenes, Joanne Murray).

The ability to sustain a sufficient level of research income is a vital attribute for success in a research career. To support our research staff in achieving this we have instituted a comprehensive mentoring and internal 'peer review' process for research staff at all career stages. This is designed to help researchers frame and develop their research proposals for funding by national or international agencies to a level that is highly competitive, and to publish their research in the most highly regarded journals in their field. Researchers notify all grant-application proposals in a *pro forma* document to the Head of School (Laurence Pearl) and Director of Research and Knowledge Exchange (Keith Caldecott) at least six weeks before a target submission date, detailing, *inter alia*, the research question they are addressing, the track record of the principal investigator and all co-applicants in that research area, and what preliminary data will be available for inclusion in the proposal. The PI is also required to identify two 'critical friends' – senior researchers not directly involved in the application, but able to read the developing proposal critically and provide essential objectivity. The Head of School and the DRKE provide feedback on the scientific strengths of the proposal. They also ensure that all the information has been provided to enable the University Research Office to progress the paperwork and undertake the negotiations that are often required with proposals to non-UK funding bodies and/or involving collaboration or networks with other institutions. Where (occasionally) a proposal is not judged to be sufficiently competitive on the basis of the *pro forma*, the Head of School has detailed discussions with the researcher to clarify for them the perceived shortcomings and identify what needs to be done in order to bring the proposal up to a level that is ready for submission.

For Wellcome Trust and European Research Council Investigator Awards, many independent Fellowships, and some Programme Grants (e.g. Cancer Research UK), an 'in-person' presentation and/or interview is a key part of the assessment process. In addition to detailed critical reading of their proposals, we provide researchers who are shortlisted for such interviews with a rigorous rehearsal and mock interview by a panel chaired by Professor Pearl, and including Prof. Caldecott, the relevant Subject Chair, and the Director of the Genome Damage and Stability Centre, Prof. Tony Carr. Our success rate in these interviews is currently running comfortably above 75 per cent. Recent successes include Prof. Laurence Pearl (Wellcome Trust Senior Investigator Award and CR-UK Programme Grant), Dr Claudio Alonso (Wellcome Trust New Investigator Award), Dr Matt Neale (ERC New Investigator Programme), Dr Eva Hoffmann (MRC Senior Fellowship and EMBO Young Investigator Programme Award), Dr Helfrid Hochegger (CR-UK Senior Fellowship), Dr Jessica Downs (CR-UK Programme Grant) and Prof. Mark O'Driscoll (CR-UK Programme Grant).

Supporting and Developing Research Students: A vigorous community of PhD students is the life-blood of any successful research community, and training the next generation of researchers is a highly valued activity at Sussex, which has a strong historical reputation as a training-ground for world leaders in the biomedical sciences. We operate a supportive PhD progression and monitoring system, with a set of 'milestone' events (progress reports, posters, oral presentations, etc.) distributed throughout the students' time at Sussex. These enable the students, the supervisors and the wider

faculty to follow students' progress and to intervene early on those rare occasions when a student is failing to thrive. As part of this, we hold a two-day PhD symposium every autumn in which all final-year students give oral presentations and face detailed questioning from staff and other students, with poster presentations from those at earlier stages of their research. The funding of home/EU PhD students presents a challenge in the present climate, where Research Council quota allocations are being concentrated in larger institutions and targeted to thematic research areas. We are ensuring a strong home/EU PhD intake thanks to more-aggressive recruitment earlier in the cycle, and facilitated by the guaranteed budgeting of a minimum of 12 new PhD students *per annum* from School funds, augmented by external Doctoral Training Awards, CASE awards (9 in the current reporting period), direct industrial support, and philanthropic funding. In parallel, we are actively pursuing the recruitment of high-quality students from developing economies – including Iraq, Egypt, Brazil, Thailand, Malaysia and China. The combination of home/EU and overseas recruitment delivered 50 new PhD students, who commenced their studies in the 2012–13 academic year, with a total registered postgraduate research population of >130.

Organisation and Identity: Research submitted in this UoA is organised in Subject Groups as follows:

Neuroscience: Chair, Prof. Guy Richardson FRS

- Learning, memory and synaptic plasticity: O'Shea, Korneev, Staras, G.Kemenes, I.Kemenes, Benjamin (Emeritus)
- Sensory systems: Kros, Richardson, Lagnado, Land (Emeritus)
- Developmental neurobiology: Alonso, Couso
- Neurodegeneration: Hafezparast, Serpell
- Neuroethology: Graham, Osorio, Collett (Emeritus), Niven

Evolutionary biology, behaviour and environment: Chair, Prof. Jeremy Field

- Social insects: Ratnieks, Goulson, Field, Hughes, Bacon
- Ecology and environment: Peck, Stewart, Scharlemann, Hill (submitted in UoA8)
- Evolutionary biology: Eyre-Walker, Morrow

Genome Damage and Stability: Chair, Prof. Keith Caldecott FMedSci

- Chromosome dynamics: Hoffman, Baxter, Bianchi, Hochegger, Neale, Tsubouchi
- DNA damage responses: Carr, Murray, Jeggo, Downs, O'Driscoll, Savic
- Stability mechanisms: Caldecott, Oliver, Doherty, L.Pearl, Lehmann, Sweet, Watts

Biochemistry and Biomedicine**:** Chair, Prof. Alison Sinclair

- Infection and immunity: Sinclair, West, Crickmore, Armstrong, Kern, Mukhopadhyay, Sacre, Waddell
- Molecular medicine: Atack, Titheradge, F.Pearl (submitted in UoA8), Prodromou, Roe, Newport, Schmid, Chevassut
- Cell signalling and regulation: Morley, Paget, Newbury, Ghezzi

4. INCOME, INFRASTRUCTURE AND FACILITIES

Long-Term/Short-Term Research Balance: We recognise a critical need to establish a strong and balanced portfolio of long-term programme funding to enable us to address and translate the questions of central biological importance on which our research strategy is focused. We have a general concern about the utility of the existing 3-year–1 Postdoc project-grant structure in advancing strategic biomedical sciences research, while acknowledging that this will be the only funding available to early-career researchers appointed to the conventional Lecturer role. Project grants can also be a useful addition to the funding associated with the Independent Fellowships on which we base most of our early-career recruitment. However, we would argue strongly that project grants foster safe tactical research which may produce easily accountable early outputs, but which deliver poor value for money and have a low likelihood of generating long-term translational impact. We also recognise the risks involved in favouring reactive research that attempts to align itself to the vagaries of 'initiatives' emerging from funding bodies.

In framing a strategic long-term approach to our research, we retain an unshakable faith that high-

quality science addressing fundamental research questions will always attract funding. With our commitment to translating our fundamental research into impact, and the accompanying increase in biomedically-orientated research that this entails, we are increasingly engaged with medical charity funding, with the Wellcome Trust and Cancer Research UK being our largest charitable sponsors, supporting numerous project grants and seven programme grants in this UoA during the reporting period (CR-UK: L.Pearl, O'Driscoll, Downs, Caldecott; Wellcome: Richardson, Lagnado, L.Pearl), as well as two Drug Discovery awards from CR-UK and two Seeding Drug Discovery awards from Wellcome. It is interesting to note that neither of these funders any longer offer conventional 3-year project grants. In addition, we have sustained a strong portfolio of Research Council funding with numerous BBSRC, MRC and NERC project grants supported, and major Programme Grants from the MRC (Carr, Caldecott, Richardson, Kros, Lehmann, Jeggo, Russell). In response to the progressive move by many funding bodies to target funding to the individual, we have made a strong commitment to Fellowship and Investigator funding as a route to supporting long-term research goals. We have a developing track record of success in winning this type of funding, which explicitly encourages the holder to take risks in their research, with three ERC Investigator awards (Carr, Morrow, Neale), two Wellcome Investigator awards (L.Pearl, Alonso), and five Senior Fellowships (Hoffman, Couso, O'Driscoll, Hochegger, Bianchi) currently active in the UoA.

Infrastructure for Research: In a previous era, the Science Research Investment Fund provided an effective mechanism for sustaining and developing research infrastructure and equipment, and research falling in this UoA at Sussex has benefited from this process. In recent years, however, the absence of a clear funding route for new equipment has placed a considerable strain on universities, which have had to explore other approaches to providing researchers with the key equipment without which their research cannot be kept internationally competitive.

Key facilities and technologies for this UoA at the University of Sussex include cell culture, large-scale eukaryotic protein production, high-throughput compound screening, siRNA screening, X-ray crystallography (large and small molecule), Nuclear Magnetic Resonance Spectroscopy, Mass Spectrometry, Electron Microscopy, and Advanced Light Microscopy, and we have made a strategic commitment to sustaining and developing these 'in-house', via a range of different funding streams. State-of-the-art X-ray crystallography has been established via a major equipment grant from the Wellcome Trust (to L.Pearl, Roe, Doherty and Serpell), while the acquisition of robotics for high-throughput synthesis and screening in the Translational Drug Discovery Group was enabled by a major equipment donation from Novartis, and a philanthropic gift from the RM Phillips Trust, who have also contributed to our recent acquisition of Next Generation DNA Sequencing (MiSeq). Significant upgrading of live-cell imaging in the Advanced Light Microscopy facilities has being provided from University funds made available as part of the 'start-up' package for Prof. Lagnado, and the RM Phillips Trust has provided assured matched-funding for the continuing development of user-friendly super-resolution microscopy. A Bioinformatics Research Manager is funded by the School to provide advice, training and collaborative input across a range of bioinformatics, cheminformatics and computational biology activities, and a University-managed facility provides High Performance Computing. Professors Pearl and Doherty, and Dr Roe, are members of collaborative Beam Allocation Groups, in collaboration with the Institute of Cancer Research and the CR-UK London Research Institute, sharing access to single-crystal X-ray diffraction facilities at the Diamond and ESRF Grenoble synchrotron facilities.

The core infrastructure funding provided by the MRC Centre Grant to the GDSC is transformative and plays an important role in sustaining the internationally competitive status of the Centre, facilitated by an integrated research environment in a high-occupancy modern building, with shared facilities and resources met from proportionate PI contributions to the core. This highly effective research support structure provides the model for future developments in the UoA at Sussex, and will be implemented in a new Life Sciences Research building, detailed planning for which is now under way. The GDSC has increased to 19 PIs with annual research income building to >£7m in the reporting period. With little room for further expansion of the GDSC in its current laboratories, the new building is a critical component of the future development of this highly successful research activity.

Building on the GDSC model, we have recently established a new Cell and Molecular Neuroscience Centre in an existing 1970s building specifically refurbished and repurposed as the 'Neuron' building. This Centre brings together neuroscience groups within this UoA (Lagnado, Benjamin, G.Kemenes, I.Kemenes, O'Shea, Staras, Korneev, Richardson, Kros, Niven, Hafezparast) with groups being

submitted in UoA4 (Koya, King, Stephens, Crombag, Badiani) in a multi-disciplinary research environment with its own distinct identity. The Centre will provide state-of-the-art facilities for electrophysiology and live-imaging at cellular, tissue-preparation and whole-organism levels, and incorporates a purpose-built zebra-fish facility. Stage 1 of the refurbishment was completed in October 2013, with completion of the entire project scheduled for March 2014.

Building for the Future: As the University of Sussex passes its 50th year, many of the innovative campus buildings designed by Sir Basil Spence are showing their age, and are increasingly unsuited to the requirements of modern world-class scientific research. The University has therefore committed to a major building programme of £120m over five years as a cornerstone of its new strategic plan.

At the head of this programme is a £60m Life Sciences Research building, which will provide state-of-the-art laboratory and office accommodation for up to 100 research groups, and managed collaborative research facilities (see above). The building will also house a 300-slot teaching laboratory able to accommodate multiple practical laboratory classes in parallel. Placing practical teaching at the heart of an explicitly research-oriented building will expose students to research culture from the outset of their studies, and will foster a strong appreciation of the importance of being taught by active researchers. The building will additionally incorporate embedded Incubator Space available for occupation by commercial organisations wanting to take advantage of the managed research facilities and co-localisation with the world-class biomedical research activities in Genome Stability, Neurosciences and Drug Discovery. A key feature of the design is a central interactive social space and catering facility which will bring researchers from the full range of disciplines in the building into the regular contact that engenders cross-disciplinary thinking and novel approaches.

The sustainability of our research activities is a key plank of our overarching research strategy, and environmental sustainability is at the heart of the new Life Sciences Research building. We are designing the new Life Sciences Research building to take account of modern scientific practice with its energy-hungry equipment and significant environmental demands from the outset, by incorporating the waste heat generated by research equipment into a 'virtual boiler-house' that will provide ambient warmth and domestic hot water, and will drive the passage of fresh air throughout the building. Combined with the extensive use of materials with high thermal inertia, piped natural lighting, grey water, and photovoltaic technology, we are aiming to construct a building where the running costs are minimised so that a maximum proportion of hard-won overheads can be dedicated to supporting the research.

Responding to Priorities and Initiatives: Our major concentrations of research excellence – especially those on the biomedical end of the research spectrum – are, to a great extent, the result of responding to long-term trends in the way in which central biological questions are asked, and what, as a society, we do with the answers. In Genome Damage and Stability, and in Neuroscience, a basic science curiosity-driven philosophy drives the questions we ask, but clear unmet needs in major human diseases such as cancer, neurodegeneration and ageing shape how we ask them. Similarly in our social insect research, fundamental issues in the evolution of complex behaviour motivate much of our research, but we address these questions in the context of organisms that play critical roles in food security.

By maintaining basic curiosity-driven research at the heart of what we do, we believe we can engage productively and effectively with emerging social and economic priorities around health and well-being, and environment and sustainability, from a position of academic strength, without having our research direction driven by the rapidly changing short-term priorities of government-directed funding bodies.

The effective retreat of large pharmaceutical companies from direct participation in target identification and the early stages of drug discovery threatens to undermine the translation of the profound new insights into disease processes that are coming from modern biology and genetics. This has been recognised by many professional academies, medical charities, and national and international research bodies, but high-level coordinated responses to this developing risk to the discovery of new medicines still remain limited, and there is a real need for 'bottom-up' initiatives from well-positioned academic groups, leveraging their basic biology insights and working with funders and biotech SMEs to generate the next generation of effective and safe drugs.

We have responded to this emerging need by establishing a Translational Drug Discovery Group (TDDG), led by two experienced and highly regarded industry figures who have brought best practice

of project management from the commercial sector and are applying this within the intellectually flexible and less risk-averse academic setting. Combined with our basic research strengths in Neuroscience and Genome Stability, we believe we are well positioned to make real contributions to drug discovery in cancer and neurological, neurodegenerative and psychiatric diseases.

Developing and Promoting Research: Each of the Subject Groups sustains an active and vibrant programme of research seminars, mixing seminars from external guest speakers with those given by local PIs and split-session presentations from Postdocs and other early-career researchers. Attendance at the relevant research seminars is mandatory for Master's and PhD students, and is supplemented by subject-specific journal clubs which are usually student-led. In addition to the subject-specific seminar programmes are two School 'special' seminars each term, featuring prominent research figures whose work carries a broad interest, and ending in a School-wide social event to enable faculty and research staff to meet and network.

A major feature of the School year is the annual Life Sciences Research Symposium, open to all researchers in the School and held each September, and which combines substantial research presentations from PIs across the full range of research in the School with two keynote lectures – The Cornforth Lecture, named in honour of Sir John Cornforth, an outstanding biological chemist who won the Nobel Prize for Chemistry at Sussex for elucidating the stereo-selective biosynthesis of steroids, and the Maynard Smith Lecture, named in honour of John Maynard Smith, the founder of biological sciences at Sussex and the most influential British evolutionary biologist since Darwin. These prestigious lectures have been delivered by major figures in UK science, including Sir Paul Nurse, Sir Tom Blundell, Sir John Walker, Sir Tim Hunt, Prof. Mel Greaves and Sir Alan Fersht.

5. COLLABORATION AND CONTRIBUTION

Collaboration

Modern biological research is, by its very nature, collaborative and PIs across the UoA are involved in both short-term and long-term national/international collaborations. These are highly productive, as indicated by the large number of collaborative/multi-PI outputs in our Output submission. Whilst the number of collaborations is too numerous to list in detail, examples of particularly powerful collaborations include links between the Genome Damage and Stability Centre and the exome sequencing activity/groups at Baylor College of Medicine in the US, for identifying new human diseases associated with defects in DNA damage responses. This link has yielded several high profile discoveries, such as the seminal link between hereditary neurodegenerative disease and defective single-strand break repair (Caldecott and Lupski, published in Nature in 2005), and more recently has been expanded into a Centre-wide collaboration. In addition, the long-term collaboration between the Pearl laboratory and the Workman laboratory (at The Institute of Cancer Research) has driven the development of Hsp90 inhibitors now entering Phase III clinical trials against a range of cancers, and which has recently been awarded the CR-UK Translational Cancer Research Prize.

Contributing to the Discipline

Our faculty maintain a high degree of involvement in their disciplines at national and international levels, serving on the advisory and editorial boards of journals, participating actively in the organisation and governance of learned bodies and discipline interest groups, and serving as members of national and international funding panels and committees. For example, Osorio and Collett are Editorial Board members, and Niven and Morrow are Associate Editors of, *Proc. Roy Soc. B*, Caldecott is an Editorial Board member, and Downs and Jeggo are Associate Editors, of *DNA Repair*; Jeggo is also a member of the Editorial Boards of *Oncogene* and *Nucl. Acids Res*. Carr is a member of the Editorial Board of *J. Cell Sci*. and Editor of *Mol. Cell. Biol.*, and Armstrong is Editor of *Yeast.*

Armstrong, Osorio and Sinclair have served on BBSRC Research Committees, while Morley co-Chaired BBSRC Research Committee B. Field has served on the NERC Grants Review Panel. Osorio and Collett have both served on the Royal Society Research Grants Committee, and L.Pearl and Collett have been members of the RS International/Newton Fellowships Panel. Caldecott and O'Driscoll have served on the Cancer Research Biological Sciences Committee, while L.Pearl has been a co-opted member of the CR-UK Biological Sciences Committee and a regular co-opted member of the Wellcome Trust Expert Review Group and Investigator and Fellowships Interview

Panel. Carr serves on the AICR Grants Committee and L.Pearl is a member of Life Sciences Panel 1 of the European Research Council.

Richardson is a member of Royal Society Sectional Committee 8 and Jeggo of Academy of Medical Sciences (AMS) Sectional Committee 2, while L.Pearl Chairs AMS Sectional Committee 1. Morley is a member of the Biosciences Panel for the Science Academy of Finland.

Consultancy and Governance

The UoA has a high degree of engagement with commercial and regulatory organisations. Crickmore, an expert in insecticidal toxins, has consulted for Syngenta and Dow Agrosciences, Hughes, an expert in insect behaviour and ecology, has also consulted for Syngenta, and Atack, an expert in drug discovery, has consulted for UCB, Janssen Pharmaceuticals and Conert Pharmaceuticals. L.Pearl, an expert in structural biology, has consulted for BerGenBio, is a scientific advisor to Abingworth Ltd, and a founding director of, and consultant to, Domainex Ltd. Caldecott, an expert in DNA repair mechanisms, has consulted for Kudos Ltd.

Osorio, an expert on cephalopods, is a member of the Boyd Group, and sits on the Ethics and Research Committee of Merlin Entertainments (SeaLife Centres). Stewart is a Trustee of Sussex Wildlife Trust and chairs its Conservation Committee, while Goulson is Honorary Life President of the Bumblebee Conservation Trust. Jeggo, an expert on DNA damage and repair, sits on the Government Advisory Committee on Medical Aspects of Radiation in the Environment (COMARE). Moore is a member of the Scientific Advisory Board of the MRC Mitochondrial Biology Unit in Cambridge. L.Pearl is a member of the Scientific Advisory Board of the Max Planck Institute for Molecular Physiology, Dortmund, Germany. Carr is a member of the Scientific Advisory Board of the University of Copenhagen and has served on quinquennial review site visits to the MRC Laboratory of Molecular Biology – Protein and Nucleic Acid Chemistry Division – and the US National Cancer Institute. Caldecott has been a member of quinquennial site-visit panels to the MRC Centres for Developmental and Biomedical Genetics (Sheffield), and Ageing (Newcastle), and Jeggo has been a member of the quinquennial review panel of the Gray Institute, Oxford.

Recognition and Marks of Esteem

Land, Lehmann, L.Pearl and Richardson are Fellows of the Royal Society (FRS) and Goulson is a Fellow of the Royal Society of Edinburgh (FRSE). Caldecott, Jeggo, Lehmann, L.Pearl and Richardson are Fellows of the Academy of Medical Sciences (FMedSci). Caldecott, Carr, Lehmann and L.Pearl are elected members of the European Molecular Biology Organisation, and L.Pearl is also an elected Member of *Academia Europaea*.

The 2011 and 2013 Genome Stability Network Medals were awarded to Lehmann and Jeggo, respectively, and Jeggo also received the 2011 Bacq and Alexander Award of the European Radiation Research Society and the 2013 Silvanus Thompson Medal of the British Institute of Radiology. Pearl and Prodromou were recipients of the 2013 Cancer Research UK Translational Cancer Research Prize, Hughes was awarded the 2008 Phillip Leverhulme Prize in Zoology, and Goulson received the 2012 Zoological Society of London's Marsh Award for Conservation Biology and was BBSRC Social Innovator of the Year in 2010. Eyre-Walker received the 2012 President's Award from the European Society for Evolutionary Biology.