Institution: University of Sussex

Unit of Assessment: 5 Biological Sciences

1. Unit context and structure, research and impact strategy

1.1 Introduction

This submission for Biological Sciences (UoA5) comprises academics from the School of Life Sciences at the University of Sussex (63.8 FTE; Headcount 71).

The School of Life Sciences is an inspiring place to do science. Our greatest strengths are the interdisciplinary nature of our work, and the application of our research to real world problems. We are distinctive due to the exceptional breadth of our research, spanning from molecular and structural biology to biodiversity. ***The School is world-leading in three areas: Genome Sciences, Neuroscience, and Ecology & Conservation.***

Our mission statement is:
To understand the mechanisms that drive biological and chemical processes; to develop innovative and diverse approaches to enhance human health, technology and the environment.

Our key research objectives are:

- To pursue multi-disciplinary and multi-scale research from molecules to ecosystems
- To advance human health, wellbeing and environmental sustainability
- To embed the values of inclusion, diversity and good citizenship in training the next generation of scientists

1.2 Unit context and structure

Research in the School of Life Sciences is structured into six Subject Groups. These are ***Biochemistry & Biomedicine***, ***Genome Damage & Stability Centre*** (GDSC), ***Neuroscience***, ***Evolution, Behaviour & Environment*** (EBE), ***Sussex Drug Discovery Centre*** (SDDC) and ***Chemistry***. Staff who have contributed to the submission in UoA5 are based in the first five of these Subject Groups. Staff within the Chemistry Subject Group are submitted in UoA8.

There are strong synergies between Subject Groups, with many collaborations and co-authorships. *The broad-ranging and interdisciplinary nature of the School allows a wide scope of research objectives to be addressed.* Whereas research in the Chemistry subject group is submitted in UoA8, many aspects of chemistry are interdisciplinary and involve academics in other Subject Groups (e.g. collaborations with the SDDC, for which medicinal chemistry is key).

Each Subject Group is led by a **Subject Chair**, who is an accomplished scientist responsible for academic leadership of Principal Investigators (PIs). Research strategy in the School is the responsibility of the Head of School (HoS), assisted by the Deputy Head of School for Research and Enterprise and the Director of Research and Knowledge Exchange (DRaKE).

1.3 Research and Impact Strategy

1.3.1 Aims of our strategy in 2014 and progress towards achieving them

The stated aims of our research strategy in 2014 were:
To sustain a breadth of high-quality biological science research, from molecules to ecosystems, focused in explicit "Centres of Excellence" and with a clear and operational commitment to translational opportunities across all our research activities. This research strategy was based upon three watchwords: Excellence, Collaboration and Sustainability.

We have succeeded in achieving the aims of this strategy as evidenced by our increased research excellence (increased number of high impact publications and consistently high level of grant income), the enhanced collaborative links of our scientists, and a shift towards translation of our findings into impacts that benefit society and the economy.

Illustrating our overall excellence in research, new awards received by the Biological Sciences at Sussex was **£73.9M** in the period 13/14 to 19/20. This shows a rise compared with **£56.9M** in the previous REF period. Our grant income per FTE is also high in UoA5, at **£173K** per annum (see section 3). Below we outline progress made in achieving the goals of the research strategy set out in REF2014.

a. Excellence

Progress and Strategy in fostering excellence: Since REF2014, the School of Life Sciences has succeeded in fostering networks of ground-breaking research, as well as supporting and developing the careers and individual profiles of numerous internationally recognised researchers. In the last assessment period, our scientists made important discoveries across the breadth of our research areas.

For example, in *cancer biology* we elucidated the roles of microRNAs in the genesis of pancreatic ductal adenocarcinoma (Castellano), showed that PIK3Cdelta expression by fibroblasts promotes progression of triple-negative breast cancer (Giamas) and identified how a tumour virus hijacks cell gene enhancers to drive lymphoma development (West). In *genome damage and stability*, we determined how multiple protein partners involved in DNA replication, repair and damage are selectively assembled through phospho-specific binding (Pearl and Oliver), determined the mechanism for the even dispersal of meiotic recombination events for optimal genetic exchange (Neale) and determined how mutations in a DNA single-strand break repair protein trigger neuropathology (Caldecott).

In *neuroscience*, we revealed that the diversity in neuronal responses to light is generated by feedback from neighbouring cells (Baden), elucidated the mechanism for sustained visual responses in the retina (Lagnado), identified biomarkers in motor neuron disease (Hafezparast) and determined how vesicles are recycled at hippocampal synapses (Staras). In *conservation biology*, we showed how land use affects local terrestrial biodiversity (Scharlemann) and demonstrated that ecological impact assessments do not reduce bat deaths at wind farms (Mathews).

<u>Areas of research excellence</u>

The School is home to numerous researchers and groups that are recognised as internationally outstanding. ***In particular, our work is world-leading in three areas.*** These are:

- **Genome Sciences:** encompassing mechanisms of genome replication, damage and repair, the control of gene expression, cancer biology, protein structure and function, cell signalling, and virology
- **Neuroscience**: focused on sensory, behavioural and computational neuroscience
- **Biodiversity & Conservation**: comprising the ecology of animal and plant communities, pollination and conservation policy

In this REF period, these areas have built capacity through new appointments and technological innovation, for example through multi-million pound investment and expansion, our Wolfson Centre for Advanced Imaging provides one of the largest concentrations of bespoke microscopes outside London, including cryo-electron microscopy, super-resolution, multiphoton and high content microscopy. Growing our researcher base in the key areas above, we have expanded the ***Neuroscience*** group from 12 to 16, and the ***Biochemistry & Biomedicine*** group from 10 to 18 (see section 2).

We continue to grow capacity in the following strategic areas, exploiting methodological and technological advances:

- Molecular structure - function analysis
- Drug discovery including medicinal chemistry
- Data-driven biology – bioinformatics, evolutionary genetics in animals and humans
- Mathematical and computational approaches to biological systems
- Integrative and systems biology – especially in neuroscience and cancer biology
- Multiscale imaging – from protein structures to electron microscopy to brain imaging

We have accomplished an objective of the previous research strategy, which was to increase the number of faculty engaged in translational opportunities. For example, since the last REF a Wellcome ISSF grant (£700K) aimed at promoting translational research has been deployed in 37 small awards of £5 – 40K across a breadth of largely collaborative Life Sciences drug discovery projects. The ***Sussex Drug Discovery Centre*** itself has been hugely successful, attracting large Wellcome Trust portfolio grants on cancer and diseases of the nervous system (see section 4).

Excellence of individuals

The School hosts a large number of *individually eminent scientists*, including 5 Wellcome Trust Investigators, 7 members of the Royal Society and 7 members of the Academy of Medical Sciences. In addition to these achievements, the majority of Life Sciences staff are well-connected internationally and play key roles in professional networks and advisory bodies (see section 4).

Faculty members have been awarded many ***prizes*** in the assessment period, spanning research activity from genome science to ecology. In molecular sciences, Professor Laurence Pearl received the Biochemical Society Novartis Medal and Prize and Professor Ulrich Rass was awarded the Chiquet-Ehrismann Originality Prize, for work on different aspects of DNA repair. Professor Tony Carr was awarded the Genome Stability Network Medal for research in model organisms and for career development support of junior colleagues. Professor Alan Lehmann was awarded the Team of the Year Prize by the British Medical Journal for work on the disease *Xeroderma Pigmentosum*, and received a CBE in the New Year's Honours 2020.

In neuroscience, Professor Tom Baden was awarded the first-ever Nature Research Award for Driving Global Impact, the Eppendorf & Nature Young European Investigator Award, the Lister Prize for Preventive Medicine and the Leverhulme Trust Prize, for his innovative work on animal colour vision in natural environments. Professor Baden was also selected by the MIT Technology Review Europe as an Innovator under 35 and obtained a highly prestigious Fellowship of the (FENS)-KAVLI Network of Excellence by the Federation of European Neurosciences.

In evolutionary genetics, Professor Adam Eyre-Walker was elected to the Royal Society in 2020. In ecological research, Dr Alan Stewart was elected an honorary fellow of the Royal Entomological Society, and won the United Nations Development Programme Equator Prize in 2015 for a Darwin Initiative Project. Professor Dave Goulson was named as a highly cited researcher by Thompson ISI in 2018, and was number 8 in a list of most influential people in conservation by BBC Wildlife Magazine in 2015. Professor Jörn Scharlemann and Professor Dave Goulson were named by Web of Science Clarivate Analytics as highly cited researchers, ranked among the top 1% in Environment/Ecology (over several years 2017 – 2020).

b. Collaboration

Progress and strategy in fostering collaboration: Since REF 2014, collaboration across all areas has increased, with a proactive approach of the Head of School and School Management Team. In addition to the formal cross-University Centres mentioned below, there are a number of informal research networks including those bringing together researchers in Cancer Research,

RNA Biology and Haematology. We have also established a school-wide knowledge transfer scheme, encouraging the sharing of research expertise in techniques and the use of specialised equipment.
Examples of enhanced interactions that have borne fruit include EBE and Neuroscience work on insect navigation, leading to the 'Brains on Board' project (with School of Engineering/Informatics) to design an autonomous flying robot. Chemistry and EBE research on pesticides and GDSC and Neuroscience work on neurological disorders (e.g. Staras and Caldecott identifying mutations in cerebellar ataxia). The School invests and participates in two large ***interdisciplinary research centres*** at the University, ***Sussex Neuroscience*** and the ***Sussex Sustainability Research Programme***.

Sussex Neuroscience is a strategic research programme that straddles four Science Schools (Life Sciences; Engineering and Informatics; Psychology; Brighton and Sussex Medical School). Set up in 2013 with £3.3M of initial central support from the University Strategic Development Fund (SDF), it is now an internationally-recognised centre of excellence for neuroscience. Twenty Life Sciences faculty are currently members of Sussex Neuroscience. The Centre is now supported through a 5-year funding model involving all four Schools; the School of Life Sciences has committed to invest over £100K p.a. over 2019-2023.

These activities include a vibrant 4-year PhD programme with lab rotations over 7 cohorts, attracting around 120-150 applicants per annum and support for students and young researchers to attend conferences and courses (>60 to date). In addition, there is funding for investment in facilities and equipment (e.g. for cutting-edge two-photon in vivo microscopy), and a weekly international seminar series.

Sussex Neuroscience has three directors, two of whom are based in Life Sciences (Professor Louise Serpell and Professor Miguel Maravall). It is focussed in the area of sensory, systems and cognitive neuroscience and psychology, with strengths in computational approaches and advanced microscopy and imaging. This alliance allows us to tackle, for example, human psychology and disorders and their biological causes, machine learning and artificial intelligence. There is currently **£24M** in open awards held by Life Sciences faculty who are members of Sussex Neuroscience. We are now also recognised as a world-leading centre in the production of open-source biomedical lab hardware and in developing research tools and training in African countries, e.g. Nigeria, Uganda. In all, Sussex houses one of the major neuroscience communities in the UK.

The ***Sussex Sustainability Research Programme*** (SSRP) brings together scientists from 8 Sussex Schools, including the School of Life Sciences, plus the Institute of Development Studies, under the leadership of Professor Joseph Alcamo, a world-leading expert on global water quality and environmental science. The key research goals of the SSRP are constellated around addressing the UN's sustainable development goals (SDGs), with its motto *'Science for the SDGs'*.

From its inception in 2015/16, primed with a grant of £3M from the Sussex SDF, the SSRP now consists of 20 internally-funded and 27 externally funded projects, and external funding to the programme has reached **£6.8M**. Of the 46 investigators who are involved in the SSRP, four faculty members are from the School of Life Sciences, with extensive involvement of post-doctoral researchers and postgraduate research (PGR) students (e.g. 5 funded PGR students). The SSRP has a growing international reputation, including advising the UK government on key policy issues, and advocating around environmental policy at the Heads-of-State SDG summit at the UN General Assembly (2019).

Professor Jörn Scharlemann leads SSRP engagement in Life Sciences with academics involved in projects encompassing 'planetary health' e.g. the conservation of tropical rainforests in Papua-New Guinea and Ecuador (Stewart, Peck & Middleton, UoA5 ICS for REF2021).

c. Sustainability

Progress and Strategy in fostering Sustainability: In the last strategy, 'sustainability' of our research strategy (not to be confused with environmental sustainability above) was defined as the promotion and improvement of the career progression of our researchers and their material environment, including state-of-the-art facilities and core infrastructure. During the current assessment period, we have ensured the promotion and career progression of our researchers (34 academic promotions), as well as their transition from nationally to internationally-recognised in their research (9 Professorial appointments). We have therefore created sustainable communities of researchers, and in particular created critical mass and vitality (as described in later sections).

1.3.2 Our current research strategy:

Key goals for the next period of our research strategy are to support and promote excellence to maintain our world-leading position in key areas, while building capacity and impact in new directions. Specifically, our aims are:

1) to embed diversity, inclusion and an equitable approach
With strong commitment to Equality, Diversity and Inclusion (EDI) principles, we look to improve participation in research by protected groups, and work towards a positive culture where all staff can achieve their potential (see section 2.3).

2) to maintain our world-leading position in key areas, while expanding synergies
We have continued to invest in and support excellent science in three key areas (Genome Science, Neuroscience and Conservation) through our staffing strategy (see below), including extensive recruitment and a proactive tenure track procedure for independent research fellows. We have also expanded key areas in the Biochemistry/Biomedicine subject group.

We have grown conservation biology research, through our participation in the SSRP, and through new hires. In the next period we will build further synergies, including those between molecular sciences and conservation, such as molecular ecology and the quantitation of the complexity of ecosystems (KPI: top ten league table position in the Biosciences by 2023).

3) to build a strong Drug Discovery Centre by expanding links between Chemistry, Genome Sciences and Neuroscience. This will catalyse new and expand existing projects aimed at translating discoveries from bench to bedside. Our new SDDC Director, Professor Jeff Hill, was recruited in 2019 from the A*STAR institute in Singapore. Professor Hill's expertise across a wide portfolio of drug development, including bringing 3 new compounds to the market, will focus on neuroscience (especially ion channel) applications, as well as cancer and other signalling pathways. The future of the SDDC has benefited from a **~£5.4M** investment by the University, with a strategic plan that will make the SDDC self-sustaining after 2022. (KPI: £3M grant funding by 2023).

4) to build a network of industrial partners, including supporting and encouraging spin-out companies and increasing our business engagement and links with local enterprise through contract research and consultancy. We will continue to encourage and support applications through funders such as Innovate UK to expand our work with micro, small and medium-sized enterprise (SMEs), supported by a permanent post for a Knowledge Exchange Framework (KEF) co-ordinator. We will enhance opportunities for UG and PG student industrial placements and increase the number of CASE PGR studentships in the School. (KPI: To establish links with 5 key industrial partners to increase business-related income for the School and form part of a proposed Scientific Advisory Board by 2023).

5) to pursue an Internationalisation agenda by strengthening links with existing partners and identifying new ones. GDSC and Neuroscience colleagues participate in a PhD programme joint with Hong Kong UST, and we run an UG education programmes with Mahidol University in Thailand. We have appointed a highly-active Director of International Affairs whose is engaging with our international office to develop a new trans-national education programme with

Southwest University (China) and further international collaborations from academics across the education and research space. We are establishing an International PhD academy with a bespoke year 1 'foundation' programme to provide lab skills, critical thinking and data analysis training to support international students before entry into their 3-year PhD (KPI: expansion of international PhD student numbers and funded international research projects and PGR opportunities).

6) to build our community of independent research fellows by actively advertising externally and internally for fellowship applicants in key research areas, making clear our commitment to career progression through our defined pathway route to a faculty position, subject to assessment of specific progress and performance indicators (KPI: expansion of our fellows from 5 to 8 by 2023 and recruitment of a second UKRI Future Leaders Fellow).

7) to obtain funding for further Doctoral Training Programmes (DTPs). In November 2019 we were awarded a £10M BBSRC DTP ('*SoCoBio*') together with the Universities of Southampton, Kent and Portsmouth and NIAB-EMR plant research station. The DTP hosts 19 students per year (including 5 CASE) over 5 years, across a wide range of projects within the BBSRC remit. We now aim to obtain further DTPs to expand our vibrant PhD student community (MRC, Wellcome). (KPI: to obtain one further DTP by 2023).

8) to invest in and develop sustainable technology hubs for molecular and chemical analysis, and to image microscopic and macroscopic biological systems. For example, In addition to our entry-level cryo-EM, we are refurbishing a building wing for installation of a JEOL CRYOARM 200 for atomic-resolution structural analysis. We also have Wellcome Trust bids submitted for a £1M upgrade of our X-ray crystallisation facility and the establishment of a Biomedical resource centre between Kent and Sussex for viral pseudotyping for Covid-19 pandemic preparedness (KPI: obtain funding to upgrade key facilities and apply a sustainable recharging model to support all core facilities by 2023).

Alignment with the agenda of UKRI

Our science shows strong alignment with the research agendas of the MRC, BBSRC and NERC, and 40% of our research income is currently from Research Councils. There are collaborations between scientists in UoA5 with EPSRC-funded work in Chemistry (UoA8: part of Life Sciences). Among the future opportunities for Life Sciences are multidisciplinary programmes on Tackling Anti-microbial Resistance and Global Food Security.

1.3.3 Impact Strategy

We have developed a strong Impact Strategy to provide the correct conditions for the delivery of impact, including the bottom-up capture of emerging potential impacts and the top-down co-ordination of impact support and strategy.

We capture bottom-up impact through:

- Encouraging the entrepreneurial quality of our faculty through Subject Chairs and the Director of Research and Knowledge Exchange, identifying, and discussing opportunities for impact at an early stage.
- Embedding impact planning in the pre-application internal approvals process for grant applications.
- Flagging up opportunities to our Impact Champion (Professor Paul Graham) who then offers one-to-one support together with an Impact co-ordinator within the School and with the central University Research & Enterprise team.

Top-down co-ordination of impact support and strategy occurs through:

- Our Research Committee with impact as a standing item

- Allocating appropriate time and flexible working for those developing impact activities, consultancies and spin-out companies.
- The use of School and University Impact awards and recognition to promote an Impact culture.

Impact Development from REF2014 to REF2021
For REF 2014, four of the impact cases focussed on the diagnosis and management of genetic diseases, whereas two addressed the conservation and management of species and environments. Our 5 REF2021 impact cases again span across research areas, ***producing impact that enhances human, health, technology and the environment***.

In the area of genetics, Professors Keith Caldecott and Penny Jeggo present a case study which develops and extends their REF2014 case study in which their research on mutations in genes involved in DNA repair has enabled diagnosis in patients with hereditary neurodevelopmental and neurodegenerative diseases, nationally and internationally. Improved diagnosis and management of genetic disease is also presented in the case study of Professor Alan Lehmann, who has played a leading role in the establishment of multi-disciplinary clinics for patients with the rare genetic disease, *Xeroderma pigmentosum*.

The remaining 3 case studies demonstrate the unit's impact in ecology and conservation. Professor Dave Goulson's work has identified the contamination of wildflowers by neonicotinoid insecticides and their lethality to bees and other pollinators. These insights contributed to UK/EU policy decisions to ban these compounds, and campaigns to persuade garden centres to stock bee-friendly plants. Animal conservation extending internationally provides the substance of the case study by Professor Jörn Scharlemann and colleagues, quantifying the disastrous exploitation of the African pangolin, providing evidence that directly led to a ban on the global trade in pangolins. The case study by Drs Alan Stewart, Mika Peck and Jo Middleton also builds on a case study from 2014 where new work and collaborations have increased impact reach in rainforest conservation and sustainability projects in Papua New Guinea and Ecuador. Co-production of projects with local communities has led to an improved understanding of conservation whilst promoting sustainable economies and community welfare.

1.3.4 Alignment with Institutional Strategy; Research Data Management, Open Research and Ethics
The research strategy of the School is closely aligned with that of the University and its Sussex 2025 strategy 'A better University for a better world'. The Head of School of Life Sciences is a member of the University Leadership Team and contributes to the development of the University Research Strategy, working closely with the new PVC(Research) who is a bioscientist, the Deputy PVC (Research) and the Heads of Research & Enterprise and Business Engagement, to ensure that the research strategy in the School is consistent with the Institutional KPIs.

Data Management
High-performance computer cluster underpins storage for the large datasets generated by, for example electron microscopy or X-ray crystallography, and extensive data generated by the School's microscopy facility are managed on an OMERO server that is maintained by ITS. Collaboration and data sharing is facilitated via a central data management device that also includes metadata across a diverse range of bespoke primary acquisition software.

Open Research
Researchers are encouraged to disseminate raw data through the University's fileshare policy, on their website, and through publication in open access journals such as Open Science, PLOS journals and bioRxiv. Our policies ensure publications are submitted to the University's research reporting database within 3 months of acceptance and funding has been available for green/gold open access publication charges. Researchers are expected to have an ORCID identifier, which links to individual faculty profile pages via our new research information system Elements, to enable ease of access and dissemination of research outputs worldwide. The School has

contributed to development of policies and processes to embed the principles of the Declaration on Research Assessment into our research.

Ethics

All new postdoctoral fellows in the School are trained in ethics and provided with links to University and School ethics websites at induction. The School has a dedicated ethics committee to scrutinise all new research proposals and projects, and we adhere to the University Code of Practice for research. Instances of alleged research misconduct are investigated by the HoS or escalated for external enquiry.

2. People

2.1 Staffing strategy

Our headcount for this submission is 66, with an FTE of 63.8. Our overall staffing strategy has been ***to hire excellent scientists who will bring breadth and depth to our research, and who will build capacity and collaborate across our different research areas.***

EDI values are embedded in our staffing strategy and *the School is committed to increasing the diversity of its staff, more diverse role models, and to provide an inclusive and flexible working environment.*

During the census period we have made the following new appointments of research-active staff to build capacity in key areas:

Title	Name	Post	Research Area
Prof	Georgios Giamas	Professor of Cancer Cell Signalling (promoted since hired)	Biochemistry and Biomedicine
Prof	Martin Gosling	Professor of Molecular Pharmacology	Biochemistry and Biomedicine
Prof	Jeffrey Hill	Professor/Director of Drug Discovery	Biochemistry and Biomedicine
Dr	Rhys Morgan	Lecturer in Biomedical Science	Biochemistry and Biomedicine
Dr	Stephen Hare	Lecturer in Microbiology	Biochemistry and Biomedicine
Dr	Tracy Nissan	Lecturer in Molecular Biology	Biochemistry and Biomedicine
Dr	Erika Mancini	Reader in Biomedical Structural Biology	Biochemistry and Biomedicine
Dr	Leandro Castellano	Reader in RNA Biology	Biochemistry and Biomedicine
Dr	Edward Wright	Senior Lecturer in Microbiology	Biochemistry and Biomedicine
Dr	Taravat Ghafourian	Senior Lecturer in Pharmaceutics & Drug Delivery	Biochemistry and Biomedicine
Prof	Fiona Mathews	Professor of Environmental Biology	EBE
Dr	Wiebke Schuett	Lecturer in Evolution Behaviour and Ecology	EBE
Dr	Maria Clara Castellanos	Lecturer in Evolution, Behaviour and Environment	EBE
Dr	Pierre Nouvellet	Reader in Evolution, Behaviour and Ecology	EBE
Dr	Christopher Sandom	Senior Lecturer in Biology	EBE

Title	Name	Post	Research Area
Prof	Ulrich Rass	Professor of Genome Stability	GDSC
Prof	Evi Soutoglou	Professor of Genome Stability	GDSC
Prof	Tony Carr	Professor of Molecular Genetics	GDSC
Prof	Thomas Baden	Professor of Neuroscience (promoted since hired)	Neuroscience
Prof	Miguel Maravall	Professor of Neuroscience (promoted since hired)	Neuroscience
Prof	Sarah Guthrie	Professor of Developmental Neuroscience	Neuroscience
Dr	Ilse Pienaar	Lecturer in Pharmacology	Neuroscience
Dr	Ruth Murrell-Lagnado	Reader in Neuroscience	Neuroscience

At the time of the last REF the major centres of excellence identified were the GDSC, Neuroscience group (which is part of the cross-School Sussex Neuroscience), Social Insects (within the EBE group) and SDDC. For the GDSC and Sussex Neuroscience, these centres remain world-leading and have enhanced their reputation in the intervening period as already described. Our staffing development plans are to continue to ***strengthen research in Biochemistry/Biomedicine and to build capacity around the SDDC, promoting a strong translational focus, and focus on mechanisms of disease, as well as broadening excellence in EBE, especially around Ecology & Conservation.*** In some cases, individuals hired at Professorial level replaced staff who had left; overall we have maintained a balance of junior and more senior staff.

GDSC

Scientists in the GDSC continue to identify key genes and pathways that regulate DNA repair and that are implicated in cancer. Since 2014 we have increased the number of faculty. These hirings have allowed us to achieve: A) The maintenance of our breadth of expertise in the genome stability area. B) Develop emerging areas of biology relevant to the overall theme of genome stability. In particular Professor Ulrich Rass and Professor Evi Soutoglou were appointed to Professorships; Rass researches the molecular mechanisms underpinning genome stability and repair of double-stranded breaks, using yeast, whereas Soutoglou investigates the balance of DNA repair pathways in relation to chromatin structure and nuclear architecture. In addition, Drs Helfrid Hochegger, Matt Neale and Jon Baxter have been promoted to faculty positions through a tenure track process from Independent Fellowships. Baxter leads on the relationship between topology and replication stress whereas Hochegger is leading on cell cycle control, systems biology and microscopy. GDSC also hosts a Royal Society-Wellcome Fellow, Chris Chan, who brings expertise on the topic of DNA replication stress and sister chromatid segregation, and who is on tenure track.

Neuroscience

The Neuroscience subject group is renowned for systems and sensory neuroscience and since 2014 we have promoted Professor Claudio Alonso (now also Subject Chair), a developmental biologist at the border between molecular mechanisms and circuit formation/behaviour and appointed Professor Tom Baden (promoted whilst at Sussex). Baden is one of the foremost young scientists of his generation having won the Eppendorf, Lister and Leverhulme prizes for his innovative work on animal colour vision in natural environments. Professor Miguel Maravall is a leading systems neuroscientist interested in cortical mechanisms of information processing. Dr Ruth Murrell-Lagnado focuses her work on signalling pathways, ion channels and mechanisms of calcium homeostasis in neurons; she also collaborates with the SDDC on translational projects. Professor Sarah Guthrie (Head of School) was recruited in 2016 to strengthen developmental neurobiology; her work focusses on the development and diseases of motor neurons. Dr Ilse Pienaar focusses on human and animal models of neurodegenerative diseases, especially Parkinson's disease, building on our strength around neurodegeneration.

EBE

Within EBE our strategy has been to broaden approaches, while maintaining excellence in social insects (e.g. work of Goulson, Graham, Niven), the promotion of Professor Jörn Scharlemann and appointment of Dr Chris Sandom have emphasised conservation, rewilding, quantifying ecosystems and environmental reparation. The work of recently appointed Prof Fiona Mathews also focusses on mammal conservation and the environmental impact of Anthropocene change; Dr Wiebke Schuett was appointed to a lectureship and works on animal behaviour and individual differences. These new faculty will contribute to our strong research agenda around the SSRP and the UN sustainable development goals. Nevertheless, we maintain excellence in evolutionary genetics and bioinformatics through the work of Professor Adam Eyre Walker, Dr Maria-Clara Castellanos and Dr Alex Bousios.

Biochemistry & Biomedicine

We have hired a number of researchers who bolster our research strengths in the control of gene expression and molecular/cellular mechanisms underpinning disease. Our areas of interest include cancer biology and signalling, microbiology (including virology), transcriptional, post-transcriptional and translational control of gene expression, genomics and protein structure and function. Newly appointed faculty include two new microbiologists; Dr Ed Wright who works on the epidemiology and antigenicity of viral zoonoses (including SARS-CoV-2) and vaccine development, and Dr Stephen Hare who studies the structure and function of determinants of bacterial disease. New appointees in cancer biology Drs Leandro Castellano, Rhys Morgan and Chris Prodromou study the genes, mechanisms and pathways that contribute to solid and haematological cancers and Dr Tracy Nissan complements the gene control area through his work on mechanisms of post-transcriptional gene control in yeast.

Sussex Drug Discovery Centre

The SDDC is being rejuvenated following the departure of two main group leaders Professors John Atack and Simon Ward. Following the recruitment of the new Director Professor Jeff Hill in 2019 and with large investments from the University, we are building on new translational and drug discovery in the areas of neuroscience, cancer and infectious disease and multiple collaborations are ongoing. These projects are beginning to bear fruit e.g. a recent £400K Therapeutics Discovery Project Award from CRUK to Professors West, Hill and Spencer (Chemistry) focused on Epstein-Barr virus cancers. The centre is also enhancing its business engagement strategy through the formation of new partnership agreements with start-ups and investors.

2.2 Staff development

Our staff development strategy places huge importance on EDI issues in recognition of the need to increase staff diversity in research and promote equity (see section 2.3). The School requires all faculty, PS and TS staff to undertake training courses in *Unconscious Bias, Recruitment Selection* and *Diversity in the Workplace*, as well as a programme of other courses including *Dignity and Respect in the Workplace*, *Trans Awareness*, and *Disability Awareness*.

2.2.1 Environment for research

We strive to provide an excellent environment for research throughout the career journey. A negotiated start-up package for new staff is provided via the School, including start-up funding, the purchase of new equipment, refurbishment of labs or other facilities, technical support, access to PhD students and in-kind support (e.g. discounted rates for facilities use). We also consider and support individual requests made for funding to attend conferences especially for junior staff.

Incentives for Research

Staff are supported to get their research off the ground with a reduced teaching load for the first two years, and reduction in administrative tasks. Our workload model ensures that staff with outstanding research performance have reduced teaching loads, and a range of research-related roles are recognised by a % FTE allocation. Our sabbaticals policy gives a term's leave, granted subject to excellent performance and contribution (e.g. having fulfilled a citizenship role).

We return a small proportion of overheads from grants to an individual's 'incentive fund' which can be used flexibly. Money received by individuals for external roles and activities can also be used to support their research (e.g. hiring a technician or part-funding a PhD Studentship).

Intellectual Environment

A vibrant intellectual environment is provided through a termly Subject Group meetings, a seminar series bringing world-leading expert speakers, and an annual away-day to exchange ideas and formulate research strategy. We organise research away days for the whole School, and a yearly School research symposium, with talks by faculty across fields, and featuring two prestigious lectures, the John Cornforth and the John Maynard Smith lectures in Chemistry and Biological Sciences, respectively. This event also features a Public Engagement Award, presented by Lady Margaret Kroto, whose husband Sir Harry Kroto was a Nobel prize-winning chemist and a member of our Faculty.

2.2.2 Staff mentoring

Excellence in research is encouraged by the assignment of a mentor for new appointees, and by reviews at an annual appraisal and at probation. The Subject Chair and the mentor initially advise new staff on grant application strategy, setting up their research programme and collaborative possibilities, as well as development of skills in grant writing, research group management and PhD supervision. All staff receive feedback on their grant applications at an early stage from two 'critical friends' and are encouraged to join the University's broader cross-discipline mentoring network:

- At appraisal, staff give an account of their activities, including planned grant applications, publication strategy and knowledge exchange/impact.
- Issues raised at probation or appraisal lead to interventions, such as change of mentorship, additional training and/or production of detailed timetable of planned grant and paper submissions.

2.2.3 Promotion

During the reporting period, 29 members of academic staff applied for promotion and 26 were successful (some were promoted more than once during the assessment period). Of these staff, 10/11 female applicants (91%) were successful and16/18 male applicants (89%) were successful. This fraction of women applicants (38%) matches the female fraction of overall staff, so staff of either gender applied at similar rates. Faculty recruitment over the most recent Athena SWAN assessment period has attained 50% gender parity at every grade of seniority.

Promotions are considered annually by a School and University Committee, along with applications for pay awards through the discretionary pay review. The School promotions committee includes our EDI lead, as well as the Directors of Teaching & Learning and of Research, and external members from other schools ensuring consideration of different workload components. The process allows for appeal/review in unsuccessful cases. In order to encourage and support staff aspirations for promotion, we implement:

- an annual promotion workshop
- active advertisement of the scheme, encouraging all staff to judge their achievements by the criteria and discuss with their line manager
- identification and encouragement of staff to apply by Subject Chairs, PIs and HoS
- clear guidance if staff fail to meet criteria or are unsuccessful, offering feedback and constructive suggestions for necessary steps

2.2.4 Early career researchers and progression

The School hosts more than 100 early-career researchers (ECRs: comprising post-doctoral research associates and independent fellows), who are encouraged to play a central role in the School. In the REF period we created the role of Early-Career Researcher Lead (ECRL), who sits on the School Management Team to provide a conduit for the views of ECRs and to develop policy. The ECRL also sits on the University level Research Staff Working Group, to advocate

for ECRs and to link them to training and career opportunities. ECRs participate fully in the life of the School, attending seminars, School meetings and research events; each Subject Group has an ECR representative. ECRs are considered for promotion through appraisals with the PIs and the same process outlined above. The University is a signatory to the Concordat to Support the Career Development of Researchers and is implementing the principles via a closely monitored plan.

Independent Fellows

Independent fellows are accorded the same status as other Principal Investigators, and benefit from the same start-up packages, infrastructure and technical support. In UoA5 we currently host one MRC career development fellow (Dr Andy Penn) one Royal Society URF (Dr Alex Bousios), one Royal Society/Wellcome Fellow (Dr Chris Chan), one Wellcome Henry Dale Fellow (Dr Sylvia Schröder) and Dr Beth Nicholls as our first UKRI Future Leaders Fellow (FLF; obtained 2020). We sponsor the most promising ECRs for these awards and provide a career progression pathway so that at the end of 5 years of a senior fellowship they can be considered for a permanent post. Several ECRs have developed their careers in this way during the REF period, and are now faculty members: Drs Jon Baxter, Maria Clara Castellanos, Helfrid Hochegger, Matt Neale and Tony Oliver.

We advertise our interest in sponsoring Fellows; Subject Chairs and the HoS play key roles in liaising with interested candidates, mentoring, development and peer review of research proposals and mock interviews. We invest significant time and resources in perfecting applications and support letters, providing a start-up package that includes access to PhD students, 'in-kind' funding through access to facilities, infrastructure, and technical support. The career progression pathway to faculty involves an interview, external references and requires certain KPIs to be met including follow-on funding, satisfactory publication, teaching and citizenship contribution to the School.

2.2.5 Technical Staff

We have around 38 core-funded technicians in the School, including those who staff core facilities and individual laboratories. We are reviewing technical services, auditing skills, creating a versatile workforce with state-of-the-art technical expertise, via the *Technician Commitment*, developing paths for secondment, skills acquisition and CPD. We are developing specialised expertise, for example, in Sussex Neuroscience there are two Grade 8 technical posts developing cutting-edge technical resources: a bioengineer developing open-source lab hardware, behavioural methods and in vivo optical imaging, and a cognitive neuroscience technician developing new techniques (e.g. connectomics).

2.2.6 PGR students

Our PhD students make a key contribution to the vitality and sustainability of our research community. These students are funded from a diversity of sources, including School funding, EPSRC, MRC, BBSRC, Leverhulme Trust, foreign governments (e.g. Saudi Arabia, Nigeria, Iraq) and charities spanning a wide range from the Alzheimer's Association to Wildlife Trusts. In particular we have hosted around 6 students a year as part of the BBSRC-funded SoCoBio DTP, 2 students as part of the Sussex Neuroscience programme, and 1-2 students each as part of an Alzheimer's Research DTC and a Leverhulme Doctoral Scholarship Programme during the assessment period. There was a fall in HESA-returned students in 19/20, but this was in part due to a deferral of start dates due to the Covid-19 pandemic.

The table overpage summarises our numbers of PhD students, the number of theses submitted, and the % that submitted within the 4-year time limit (in the range of 91-100%).

PGRs by financial year (UoA5)	13-14	14-15	15-16	16-17	17-18	18-19	19/20
Applications	650	443	428	497	376	261	262
Offers	47	56	35	43	52	29	35
New Starters	32	35	34	29	29	33	23
Submitted	18	19	25	34	25	33	30
% Submitted 4 years	100	100	92	91	96	97	97
PhDs awarded	29	15	25	39	26	34	30
HESA returned	154	158	178	178	162	161	146

We have an active Director of Doctoral Studies (DDS); all PhD student matters are handled by a termly Research Degrees Committee meeting including Research Degree Convenors (RDCs) from all Subject groups.

PhD student progress is supported by a team of at least two supervisors and monitoring occurs after 3 months and thereafter every 6 months. Each student has a thesis committee (TC) made up of their second supervisor and two other experts, who have special expertise. At each TC, the student presents their progress and future prospects, receive feedback and advice. Students submit research reports for their TCs and following review and progress reports from the committee, their progression to the next year is reviewed by the DDS. Students can raise any confidential concerns related to their supervision or project progress at the TC, or via the DDS at any time. The DDS can liaise with the HoS to take necessary steps to resolve any issues.

Students present at least one talk within their Subject Group during their PhD, at an annual PGR symposium, which includes careers workshops. Students benefit from an extensive programme of transferable skills training run by the Doctoral School; topics include balancing workload, writing skills, and thesis 'Bootcamp'. Students in Subject Groups frequently self-organise to run journal clubs, techniques groups or social events.

PGR student wellbeing

We acknowledge the issues around student mental health and resilience, especially during the pandemic. A project on PhD student mental health and wellbeing (U-Doc) at university level funded by the Office for Students has created a PGR wellbeing toolkit. The HoS is 'Wellbeing Lead' for the SoCoBio DTP, and we are engaging with PGR student wellbeing champions to provide a wide range of support for students, as well rolling out bespoke mental health training for academics and professional services colleagues. The DDS plays a key role in ensuring that appropriate help is directed to students with any difficulties. The University provided a hardship fund to support PhD students during the pandemic.

Inclusivity

PhD programmes involving the School, whether externally funded (BBSRC DTP, Leverhulme) or internal (Sussex Neuroscience) select on a competitive basis, but strive to be inclusive and to increase the representation of minorities in our PGR community; shortlisted candidates receive bespoke interview training. We advertise widely through a broad range of media, including BBSTEM, using inclusive wording and links to our family-friendly policies. The EDI leads in the School have reformed application and interview procedures and policies for our DTP (interviewing in pairs reflecting gender and ethnic balance, open-ended interview questions and application forms) and we are now implementing these changes for all PGR recruitment.

2.3 Equality, Diversity and Inclusion

A key goal that is embedded in our School strategy is:

To create a more locally and internationally-connected community of Life Scientists, whose values, goals, and culture are shared by all. This will in turn allow us to support and sustain our research excellence to take it to the next level.

Ongoing initiatives in the School to achieve this goal include the following:

1. Robust systems to ensure that our School culture is fair, including transparent workload allocation. EDI issues are overseen by the Senior Management Team, an EDI Lead and a dedicated committee to monitor progress, underpinned by a budget of £10K p.a. We are currently testing a workload model with full transparency for academic faculty. We welcome applications from those requesting flexible working or job sharing; 5 of the 71 staff who are returned in REF2021 work less than 1 FTE. We support staff and students with caring responsibilities through helping with workload management, flexible working and regular check-ins, especially through the pandemic.

2. A clear system for ensuring dignity and respect, and reporting and monitoring harassment. We have a staff support network, trained in mediation techniques, which offers confidential reporting and advice. The Head of School personally deals with many issues, and designated staff members or external individuals acts as a mediator in difficult cases. We use School surveys and meetings to gather views on our culture, widely sharing outcomes, and resulting in improved communication, transparency and decision-making. This feedback has led to creation of a *Code of Conduct for Meetings*, a campaign around email etiquette, and implementing EDI training for all staff. We are currently trialling use of a software for reporting any incidents of concern.

3. A Race Equity Action Plan to embed anti-racism in our culture. Together with student race equity advocates (REAs), we have co-authored a Race Equity Action Plan (REAP) which was launched in late 2020 (and is monitored via a REAP committee). Key priorities of this plan include monitoring and improving staff training in cultural awareness, diversity and unconscious bias, addressing the lack of BAME role models in academia, increasing the low numbers of BAME PhD students, and remedying the BAME awarding gap. We have increased representation of scientists of colour in seminars and School events and run a yearly symposium to promote the career paths of BAME academics in black history month.

4. Promotion of an inclusive culture. As mentioned in section 2.1, we strive to increase the number of women and minority staff, providing more inclusive role models. We have therefore completely overhauled our recruitment advertisements and job packs, with cultural awareness training of all those involved in recruitment and management. We also seek to raise the profiles of LGBT+ scientists through presentations and events led by LGBT+ scientists. Our seminar policy supports inclusive role models, by encouraging organisers of seminars to achieve 50% female speaker representation at all School-supported seminar series and events, and an equitable representation of all protected and minority groups

5. Renewal of Athena SWAN Silver Award. ***We obtained a renewal of our Athena SWAN Silver Award in 2019***, thanks to an excellent self-assessment team. We were particularly commended in our Athena SWAN renewal for improving culture across the School through an array of activities and events spanning from Wikipedia edit-a-thons to career days that explored academic and non-traditional options and showcased women and BAME scientists as speakers. For example, Soapbox science features the work of our female scientists presenting their work atop a soapbox on Brighton pier.

Equalities Impact Assessment of our REF submission
Our Senior Management Team conducted an assessment of the equalities data of our REF outputs. This showed that 47.3% of staff are female, whereas 24.3% made REF submissions. This is largely due to the representation of female staff in the faculty with teaching-focussed contracts. There was no significant difference in the representation of disabled staff (3.9% of the total, with 5.7% submitting to REF). 19.0% of staff reported their ethnicity as BAME, whereas

11.4% submitted to REF. There was also an overrepresentation of staff over 50, who formed 52.9% of those submitting to REF, but only 26.8% of the staff overall. The issues raised here are being addressed by mentoring and structured planning of publication as described in section 2.2.2.

3. Income, infrastructure and facilities

3.1 Research Income and strategy to generate income

The School brings in around 40% of the total research income of the University of Sussex. This UoA performs well in grant capture; a snapshot of the total value of live, open grants in June 2019 was **£83.3M**. New awards received in the assessment period totalled **£73.9M** compared with **£56.9M** in the previous REF period, as illustrated by the research per PI, which is £173K p.a.

The table below shows the grant income in terms of value sought, new awards by year and income. The School maintains a high level of grant applications (e.g. 142 applications in 2018/19) with a high success rate (33%), which is above the national average. The lower research Income in 19-20 may be partly due to delays in grant decisions caused by the pandemic, and we are currently recovering momentum.

3.1.1 Research Income

Grant Capture during REF period (1000s)

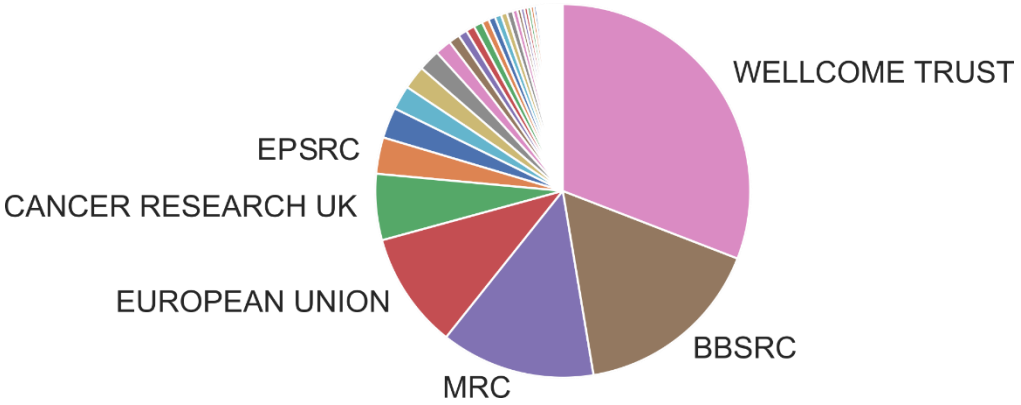
Year	13/14	14/15	15/16	16/17	17/18	18/19	19/20	Total
Applications	40,526	43,647	45,638	45,837	41,286	42,740	43,755	303,429
Awarded	9,664	9,152	18,281	11,710	8,319	8,921	7,806	73,853
Income (UKRI, RS) (29/03/21)	5,622	5,316	4,819	4,560	3,715	4,155	3,879	32,066

On average over the past 5 years, 40% of applications by value have been made to UK Research Councils; 41% to UK Charities, and 13% to EU, 6% to UK industry and all other sources. The average income over the same period reveals a similar average profile, but with a year on year trend for increasing income from the Charity sector, offset by a decline in income from UK Research Councils and EU.

There are numerous large awards. Of particular note are Wellcome Investigator Awards (Pearl, Alonso, Carr, Neale, Lagnado, Baden), Wellcome Drug Discovery Portfolio Award (SDDC,GDSC), CRUK senior research fellowship (Hochegger), CRUK Program grants (Caldecott, Pearl/Oliver), Royal Society Research Fellowship Award (Caldecott) and NERC Knowledge Exchange Fellowship (Mathews).

MRC Programme grants (Caldecott), MRC projects (Castellano, West), BBSRC projects (Staras, Baden, Doherty, Murray, Pearl, Paget, Graham, Niven, Stewart, Hochegger). Rass and Soutoglou obtained prestigious Academy of Medical Sciences Professorship grants. Our scope of other funding sources is exceptionally broad and resilient, ranging from DEFRA to medical charities (e.g. CRUK, Blood Cancer UK, Breast Cancer Now, Great Ormond Street Hospital, Niemann Pick Research Foundation, Worldwide Cancer Research, Alzheimer's Association, Motor Neuron Disease Association), to Wildlife charities e.g. Vincent Wildlife Trust, British Beekeepers' Association.

Proportion of UoA grant funding by funding source



3.1.2 Strategy to generate income

We have set targets to increase the income per PI per annum (from £173K per PI to the Russell group median of (187K per PI) and increase the proportion of UKRI funding (from 40% to 45%), as well as applying for large strategic grants.

Our strategy is:

a) to provide central support for nascent projects and pilot work that can become self-sustaining, SDF: The University provides several funding streams, including the large Strategic Development Fund (SDF). SDF has provided significant infrastructure for the School via an allocation of **£16.7M** during the REF period, with the aim of pump-priming research centres and individuals so that their research can become self-sustaining. Of this, ~£5.4M was provided for the SDDC, £2.4M for the GDSC and £3.3M for Sussex Neuroscience. Around £5.2M was given in extra start-up funding for new staff across the School, including lab refurbishment, studentships and equipment. £464K funded Professor Tony Moore's translational work on novel fungicides.

A Wellcome ISSF award of £700K has over 5 years provided around 37 small grants for pilot work preliminary to larger applications, and an MRC Confidence in Concept grant funded 10 small grants on translational topics, especially drug discovery, neuroscience, cancer and infectious disease. ISSF funding has led to new larger grant awards (e.g. from MRC) with further external bids submitted and in development. The University also runs a yearly application cycle for the Research Development Fund (RDF; provides grants of up to 25K) and a bequest by an alumnus of £100K has funded 7 pilot projects of up to £15K across the Biochemistry area, including 2 on COVID/SARS-CoV-2.

b) to set targets for increasing grant income per PI and grant success

Appraisal and probation processes are used as an opportunity to set targets and discuss strategy around grant applications with individuals, setting a calendar and goals where required (see section 2.2.2)

c) *to provide mentoring and support to increase grant success*

Each academic is provided with a mentor when appointed and is asked to acquire input on grant proposals from two 'critical friends' prior to grant submission. Such mentoring is managed within Subject Groups by the Subject Chair, who may facilitate integration of more junior colleagues into networks, e.g. as co-investigators in large grant bids, or by suggestions for collaboration. New faculty are allocated a PGR student and technical support to assist them with pilot data generation and are given subsidised access to Technical Hubs.

3.2 Infrastructure and Facilities

3.2.1 Investment in the Life Sciences Estate

In the last REF submission, a new Life Sciences Building was at the planning stage. However, due to University-level financial reconsiderations this plan has not progressed and has been replaced with a commitment for a financial package for the School to enable strategic laboratory upgrades, redevelopments and renovations. The Vice-Chancellor and executive group have made a clear commitment to a substantial investment in the fabric of the Life Sciences estate and its core infrastructure, to ensure that the excellence in research can continue unhampered.

3.2.2 Technical Hubs

The School has Technical Hubs that house equipment providing excellent facilities spanning a range of disciplines including analytical chemistry, molecular and cellular biology, protein work, electrophysiology, imaging, and covering a range of animal models including ants, bees, *Drosophila*, snails, zebrafish and mice.

We maintain core technical hubs for mass spectrometry, X-ray crystallography, siRNA screening and NMR. Mass spectrometry is used by chemists, structural biologists and biochemists, and is employed in studies including drug design and optimisation and analyses of environmental pesticides. X-ray crystallography has underpinned the elucidation of the structural basis for the function of macromolecular complexes involved in DNA damage and repair and chaperone pathways and the development of structure-led drug discovery projects across multiple areas.

The Wolfson Centre for Biological Imaging was established using a 1.5M grant from the Wolfson Foundation (led by Carr and Lagnado) and houses 18 sophisticated microscopes, including confocal, multiphoton, spinning disk and super-resolution. It is supported by two Facilities Managers and has enabled, for example, *in vivo* calcium imaging of neuronal activity to elucidate mechanisms of visual transduction (Lagnado, Baden) and visualisation of a new role for a mitotic kinase as a chromosome guardian maintaining centromere integrity during mitosis (Chan).

We are currently expanding our Electron Microscope capability, with high resolution cryo-EM, funded by £2.5M philanthropic donation and Wellcome Trust support totalling £400K, which will be used across multiple subject groups (especially GDSC and Neuroscience) to allow *in situ* atomic-resolution structural analysis of large complex and flexible macromolecular complexes, e.g. DNA repair, chaperone, transcription factor and chromatin regulatory complexes, synaptic components and amyloid fibrils.

There are a wide range of tissue culture facilities for cell lines and primary cells and microbial work. The School Cell Bank recently received NHS approval to operate as a licensed Research Tissue Bank accessible to researchers. For ecological work, we maintain field vehicles, greenhouses and a large range of field equipment that have enabled projects such as grassland reparation on the South Downs (Stewart). Sussex is part of a block allocation group with the Institute of Cancer Research which provides regular shifts on X-ray microscopy beamlines for 3D structure determination at Diamond Light Source, Oxford, and for a set of fragment-based drug discovery projects. This provides free access to their XChem (X-ray structure-accelerated, synthesis-aligned fragment medicinal chemistry) facility and a range of intellectual property-free fragment libraries.

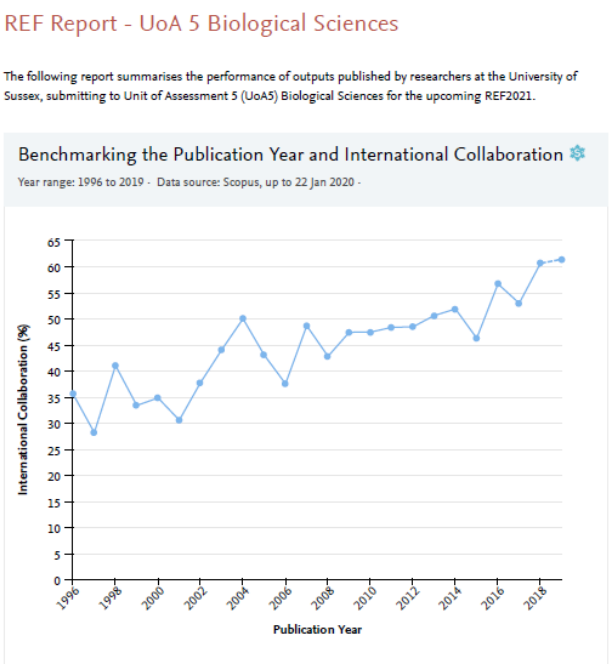
Other than investment via the SDF, we have invested significant School funds **(~£2.5M**) in the assessment period on updating and refurbishing laboratories for individuals and groups. This has included the Neuroscience building and Baden labs (£1.2M) new tissue culture facilities and containment levels (£16K; Wright, Castellano), animal facilities, EM, and minor works for a range of new faculty (Mathews, Adesakin, Pienaar).

4. Collaboration and contribution to the research base, economy and society

4.1 Collaboration

Biologists in Life Sciences have extensive collaborations, with broad and diverse contributions nationally and internationally. For example, Nouvellet works with Imperial College colleagues to model the spread of viral disease, including most recently SARS-Cov-2 and the impact of changes in mobility of individuals during lockdown. Wright has worked with collaborators at Kent and internationally to apply expertise to real world crises by developing drugs, vaccines and diagnostics targeting many emerging and zoonotic viruses (e.g. rabies and Ebola), and in the current Covid-19 pandemic, in collaboration with multiple national and international teams in SARS-CoV-2 vaccine, drug and diagnostic development.

Almost all faculty have at least one collaboration with a scientist overseas. A snapshot in 2018 suggested that of the 130 funded projects or studentships that involved a collaboration outside Sussex, around 30 of these involved international partners, with countries as diverse as the USA, Mexico, Brazil and India as well as Europe. The graph below shows the proportion of publications from UoA5 that have been internationally co-authored over a 20-year period. There is a clear upward trend with an increase from ~50% to ~60% over the assessment period.



Preferred partners for collaborations include Hong Kong University of Science and Technology (HKUST) with academic visits, student summer projects and shared PhD students, and we are developing links with the Champalimaud Institute (Portugal). Other institutions with whom collaboration is frequent include Imperial College, Institute of Cancer Research, UCL, Oxford, Cambridge and Exeter. Through our BBSRC DTP, we are building collaborative links with the Universities of Southampton, Kent and Portsmouth, through joint supervision of PhD studentships that has already led to new working relationships and a new grant award (BBSRC grant to West and Fenton (Kent).

A recent survey showed that the School had 727 internationally co-authored papers during the assessment period. The graphic overpage shows our international collaboration, including the academic (top) and the non-academic sector (bottom), highlighting in particular the geographical reach of our work and our collaborations across Europe, north and south America and Africa.

UoA5 Biological Sciences at the University of Sussex co-authorship with International authors| Publications between 2014 to 2019

Entity: Publications in UoA 5 Biological Sciences with international collaboration | 2014 to 2019 ·
Year range: 2014 to 2019 · Data source: Scopus, up to 22 Jan 2020 ·

Scholarly Output per country/region

0 0 0 0 0 1 173 0 665

Scholarly Output

The map above summarises the geo-location of the international co-authors of UoA5. The data shows that collaboration is global with an indication of co-authorship with every region.

UoA5 Biological Sciences at the University of Sussex co-authorship with the non-Academic sector| Publications between 2014 to 2019

Entity: Publications in UoA 5 Biological Sciences with author(s) with both academic and corporate affiliation | 2014 to 2019 ·
Year range: 2014 to 2019 · Data source: Scopus, up to 22 Jan 2020 ·

Scholarly Output per country/region

0 0 0 0 0 1 11 27 53

Scholarly Output

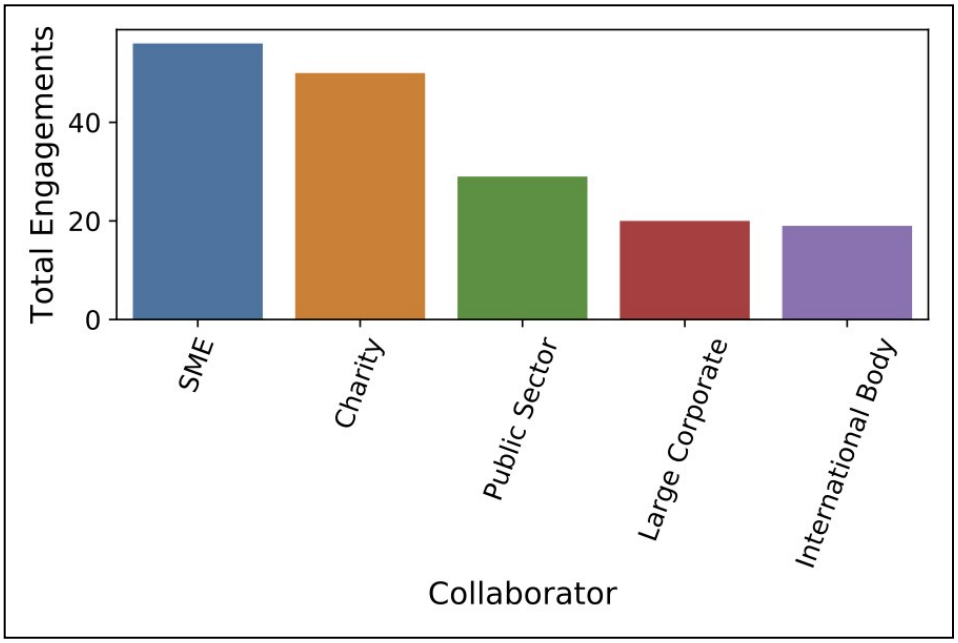
Looking at the geo-location of the non-academic sector collaboration, it shows the extensive partnership with UoA5 researchers, with the main partnership coming from the USA and Europe.

4.2 Engagement with other stakeholders and industry

The School of Life Sciences has a very large portfolio of collaborations with organisations beyond higher education, and a strategic priority area is to broaden and deepen our relationships with industry. A current snapshot of this engagement shows around 160 projects with external stakeholder engagement. Of these, ~50 were with business, ~40 with third sector and ~30 with the public sector. The portfolio of funded projects involves as the top stakeholders, Cancer Research UK, Action Against Cancer, the National Cancer Institute, Merck, the Alzheimer's Society. Janssen Pharmaceuticals, WISTA laboratories, the Motor Neurone Disease Association, GlaxoSmithKline and Colorcon. Co-funding for PGR studentships within Life Sciences depends on bodies as diverse as EVOTEC, Essen Bioscience, Phlorum Environmental Consultancy, Agform, Photek Limited, Tocris, the Alzheimer's Society, the RSPB and the Mammal Society. A further 40 companies are partners of our SoCoBio BBSRC-funded DTP.

The graphic below shows the large variety of engagements in which Life Sciences academics are involved, divided up according to SMEs, charities, public sector large corporate, and international bodies/networks.

External Engagements of Life Sciences Academics by type



4.3 Business engagement and Knowledge Exchange

13 academics across the school held consultancies with industrial partners during the REF period (including Mathews, Giamas, Lehmann, Crickmore, Wright, Staras). For example, Professor Alan Lehmann FRS consults on a number of genetic conditions in collaboration with Guy's and St Thomas's NHS Trust. Professor Louise Serpell works with the company TauRX to develop therapies for Alzheimer's Disease. Dr Neil Crickmore consults for CamTech on arthropod management strategies. Wright consults for Saiba AG on strategies for neutralisation of SARS-CoV-2. Work in the laboratory of apiculture and social insects (Prof Francis Ratnieks) has been sponsored for many years by Rowse Honey, including a postdoctoral research associateship.

Janssen is sponsoring Professor Leon Lagnado's work on animal models of neurodegeneration, while Dr Ed Wright works with Kymab on novel vaccine development. and sits on the Scientific Management Committee at DIOSynVax Ltd, advising on development of new technology that will significantly accelerate vaccine development. Enterprise Therapeutics is a drug discovery company dedicated to research and development of therapies for respiratory disorders, which is based at the Sussex Innovation Centre with staff housed in SDDC through a contract research agreement. Professor Martin Gosling, a previous member of Life Sciences' faculty, is the

company's Chief Scientific Adviser. The company's treatments programme for cystic fibrosis was recently acquired by Roche in a £75M deal.

4.3.1 Spinouts

Creation of spinouts is encouraged, and experienced support and seed funding is offered via the Sussex Innovation Centre, which is located on campus and works closely with the University. The successful spinout 'Ecotype Genetics Ltd' was founded by Mathews (EBE) and Etheridge and Carr (GDSC), using DNA technologies to identify protected species from samples collected during ecological surveys. Moore's research on alternative oxidases involves collaborations with industrial and clinical partners to develop novel fungicides and therapeutics. He is currently spinning out a company 'AOX Technologies Ltd' to commercialise his fungicides. Giamas is also currently in the final stages of setting up a spinout developing therapeutics targeting the LMTK3 kinase for cancer treatment.

4.3.2 Consultancy

Current work is looking to enhance the School's consultancy position (current consultancy income is ca £60K p.a.) and establish new links with business including via contract research agreements by working with Research and Enterprise and our new KEF officer on a range of activities to enhance academic and business engagement. Several of our ecologists (Scharlemann, Peck, Goulson, Mathews) collaborate with government, local authorities, learned Societies and charities to educate, promote better environmental attitudes and influence landuse policies. Sandom and Stewart work with Knepp Estate and the South Downs National Park on rewilding/environmental reparation projects.

4.4 External Engagement of Individuals

4.4.1 Editors and Editorial Boards

Our scientists hold Editorships of numerous journals across the spectrum of our research: *Genome Biology and Evolution* (Eyre-Walker; Editor-in-Chief), *Frontiers in Structural Biology* (Serpell), *J. Invertebrate Pathology* (Crickmore), *PeerJ* (Scharlemann), *Scientific Reports* (Watts), *Molecular and Cellular Biology* (Carr), *Journal of Cell Science (*Carr), *Genes & Genetic Systems* (Carr), *Frontiers in Structural Biology* (Serpell), *Oncogene* (Giamas), Oncogene (Castellano), *DNA repair* (Lehmann), *BMC Veterinary Research* (Wright), *Insect Conservation and Diversity* (Stewart), *Frontiers in Molecular Biosciences* (Prodromou). A large number of faculty are also members of Editorial Boards.

4.4.2 Grant panels

Our academics sit on various grant panels and professional bodies attesting to their external profiles: Wellcome Trust Panel of Experts and Agence Nationale de la Recherche (Morley), Scientific Evaluation Committee (Rass), Human Frontiers Long-Term Fellowship Committee (Eyre-Walker), Health Research Board and INSERM (Castellano), EU Marie Sklodowska Fellowships and French Higher Council for Evaluation of Research and Higher Education (Maravall), ERC Starting Grants (Guthrie), ERC and ANR (Pearl), Scientifica Advisory Board of the Max Planck Institute for Molecular Physiology; CRUK Review panel; EMBL Grenoble quinquennial review (Pearl), NC3Rs (Giamas), Parkinson's UK; the Alzheimer's Society; South African MRC (Pienaar), CRUK New Investigator's Committee; Quinquennial Review Panel, CRUK/MRC Oxford Institute for Radiation Oncology; CRUK Science Committee; CRUK Postdoctoral Travel Award Scheme Committee (O'Driscoll), Associazione Italiana per la Ricerca sul Cancro (AIRC) panel; Kilham Prize, Canadian Council for the Arts (O'Driscoll).

4.4.3 Other Esteem Factors

Dave Goulson and Jorn Scharlemann most highly cited researchers of Clarivate Analytics (2017, 2018, 2019). Dave Goulson's book the Garden Jungle (2020) reached bestseller lists in the UK Times, won the Zoological Society of London Clarivate Award for Communicating Science.

4.5 Research Performance and Citations

A recent analysis showed that of 1,359 scholarly outputs by 66 researchers from 2014-2020, the field-weighted citation impact was 2.22, the citation count 33,398, and the average citations per publication was 24.6. The UoA had 21.7% of its publications in the top 10% most cited worldwide.

4.6 Media and Public Engagement

4.6.1 Media

A dedicated Communications and Events Officer liaises with University Media Relations Managers to identify newsworthy research findings and to put researchers in touch with media contacts. Our academics are commonly heard and seen on TV and radio; Professor Dave Goulson took part in Radio 4's '*The Life Scientific'* for example. Our research features in international publications; Dr George Kemenes and Dr Sergei Korneev's research on memory mechanisms was featured by the National Geographic.

A recent summary of Altmetrics Attention revealed 101 policy mentions and 2433 news mentions of the UoA5 outputs. In addition, out of the 900 outputs published by UoA5, approximately 85% have been mentioned in altmetrics sources. There were approximately 41k Twitter mentions, and 1k Facebook mentions, indicating interaction with members of the public.

This analysis also demonstrated particular research outputs with significant media attention; Professor Dave Goulson's discovery of a 75% decline over 27 years in total flying insect biomass in protected areas (coined an 'insect apocalypse' by media) is the top mentioned output for Sussex, and is 2nd in the UK; other top research outputs are studies on interventions in the Ebola and Zika epidemics (Nouvellet), saving the world's terrestrial megafauna and an analysis of the effects of pesticides on bees.

4.6.2 Public Engagement

The School has a published Public Engagement strategy which is available at: http://www.sussex.ac.uk/lifesci/public-engagement We have an outstanding set of activities with a dedicated co-ordinator, part-funded by the School and part by the Wellcome Trust. We take part in science festivals, visit schools and connect with charities, businesses and the local community, bringing our outreach to a large variety of stakeholders.

The School sponsors small community grants of £500 to projects that engage a specific community under-represented by science, along with a larger 'Proof of Concept' grants for significant potential projects. We recognise public engagement in the work-load model, promotions criteria and internal acknowledgments. The annual Kroto Award for Public Engagement (mentioned in 2.2.1) also provides recognition and £1,000 towards the recipient's activities.

Engagement with young people:

Dr Jon Baxter established the *School Partnership Researching Chromosome Stability* (or SPaRCs; Royal Society Partnership grant) programme to involve year 12 /13 students in conducting chromosome stability experiments for live research projects; data is fed back to the Baxter lab for further investigation. In an ecological project *Through the Bush Backwards,* Dr Chris Sandom collaborated with a local artist to create a graphic short story of Sussex's wild past, hoping to inspire young people to conceptualise their vision of future Britain

Citizen Science and Engagement with the general public:

A range of projects focus on ecology and conservation of our local Sussex landscape, engaging with farmers and the general public on issues such as reparation of damaged chalk grassland (Dr Alan Stewart) and public understanding of the decline in pollinators and the impact of pesticides (Dr Beth Nicholls and Professor Dave Goulson). This project involves more than 100 Brighton gardeners, along with growers in Kolkata India, who are 'citizen scientists' as part of Team PollinATE, worked closely with The Buzz Club, a citizen science club working to make gardens havens for wildlife.

International Public Engagement:
Alongside our local and national work, some of our researchers are working on Public Engagement overseas. A charity set up by Professor Tom Baden and Dr Lucia Prieto-Godinho (Crick), TReND in Africa (Teaching and Research in Natural Sciences for Development in Africa), supports scientific capacity building across Africa. The charity runs biomedical training courses, academic volunteering, and disseminates scientific knowledge and technical expertise, building affordable lab equipment using 3D printing. Dr Mahmoud Maina is the Outreach Coordinator for TReND and is inspiring and empowering future generations of scientists through across Africa.

In conclusion:
The School of Life Sciences is a diverse, collaborative community and an exciting place to do science. We have a strong strategy to maintain our vitality and sustainability going forward, despite the challenging circumstances of the post-pandemic world. Our research is strengthened by its interdisciplinary nature and is making a better world by providing economic and societal benefits.