Institution: Queen Mary, University of London (QMUL)

Unit of Assessment: Main Committee A, sub-panel A5 (Biological Sciences)

a. Overview

Staff submitted in UoA sub-panel A5 (Biological Sciences) are located within the School of Biological & Chemical Sciences (SBCS) that forms part of the Faculty of Science and Engineering at QMUL. SBCS was created in 2006 by a merger of the former Schools of Biological Sciences and Chemistry. A substantial restructuring of SBCS took place in 2011-2012, in order to focus SBCS activities around its research strengths, reflected in 4 new divisions of the School: Chemistry & Biochemistry, Cell & Molecular Biology, Organismal Biology and Biological & Experimental Psychology, with the identification of clusters of research excellence - Aquatic Ecology, Evolution & Genetics, Biological Psychology and Structural Biology & Photosynthesis. This was accompanied by a new initiative in Computational Biology & Computational Chemistry, with recruitment of new staff active in research in these areas to all four divisions in the SBCS. In the research areas covered by this submission, substantial College investment during the REF period is reflected in the recruitment of new research active-staff (including **Bessant**, **Clayton**, **Duffy**, **Eizaguirre**, **Harrod**, **Kratina**, **Mareschal**, **Pluess** and **Wurm**), combined with the transfer of **Hurd** and **McElligott** to Teaching & Research contracts based on their research performance during the REF period. Our appointment strategy is aimed at strengthening our clusters of research excellence, with appointments being made within each research cluster. We have approval for the appointment of a further five research-active staff during 2014. Investment in new staff is combined with major investment in SBCS's research infrastructure (see Section d.), aimed at developing world-class space and facilities for each of our areas of research excellence. In parallel with the strengthening of our research activities, teaching has been streamlined, with the appointment of a small cohort of Teaching & Scholarship staff to take on some of the major teaching and administrative roles, thus ensuring sufficient research time for research-active staff. By maintaining diverse areas of research excellence within the same School we can sustain and promote distinctive areas of interdisciplinary research, in particular at the Biology:Chemistry and Biology:Psychology interfaces. Our success in these areas is indicated by, for example, the Nature publications of **Krauss** at the Biology:Chemistry interface and the €3.47M award of an ERC Advanced Fellowship to **Chittka** at the Biology:Psychology interface. Building around our areas of strength also achieves alignment with the priorities of Research Councils and other funding bodies, thereby enhancing sustainability. SBCS is a leading participant in a major College initiative to develop a new Life Sciences Institute, to be housed in a new building on the College's Whitechapel campus. This will be the focus of School and College activity in Biomedical Science, with further major investment in this area.

b. Research strategy

Overview of research plans

Research plans in Biological Sciences are based around developing distinctive, synergistic clusters of research excellence, by focussing investment in staff, space and facilities around our distinctive strengths. These strengths (detailed below) are in Aquatic Ecology, Evolution & Genetics, Biological Psychology and Structural Biology & Photosynthesis. We will continue to house each of these distinctive research groupings within the same School, together with chemists specialising in catalysis, organic synthesis, computational chemistry and photochemistry, fostering unique interdisciplinary links. In addition, SBCS has a strong interest in Biomedical research (exemplified by Dr Shane Wilkinson, submitted to UoA1) that it is developing via its leading role in the College's Life Sciences Initiative, which will strengthen links with the School of Medicine & Dentistry with a purpose-built research institute on the College's Whitechapel Campus. The new institute will eventually house SBCS staff with research interests in Biomedical Science, including Structural Biology and Bioinformatics.

Mechanisms for promoting research

The SBCS Research Strategy Group (RSG) provides a forum for developing new research initiatives, especially cross-disciplinary consortium grant applications and significant infrastructure and equipment bids. RSG is chaired by the Director of Research (currently **Leitch**) and its membership includes the Head of School, Heads of Division, Director of Industrial Innovation, as well as elected representatives from the academic staff, postdoctoral and postgraduate communities. RSG's remit is to maintain and enhance a stimulating environment for research, to

identify strategic hires of staff and to increase SBCS's research resources, in terms of equipment, research staff and postgraduate students. It oversees research mentoring (including mentoring for PDRAs), the internal peer-reviewing of grant applications, allocation of research studentships and allocation of awards from a School 'Pump Priming Fund' (£50K p.a.) and "Continuation funding", where modest additional resources can enable high quality publications. Peer review of all grant applications exceeding £50K enhances success rates and spreads best practice. RSG forged a link with Innovayt, a consultancy that facilitates applications for EU funding, resulting in the successful award of a Marie Curie Initial Training Network (ITN) grant. This link has now been adopted by the faculty. Annual research away days serve as a wider forum in which all academic staff can participate. SBCS employs a Research Services Manager who gives targeted grant information to staff and provides support for grant applications and grant management. SBCS has adopted a formal process by which time committed to research projects and students, as well as time for community research-related tasks, can be explicitly traded off against teaching and administrative roles through a workload model. For example, credit on the workload model is given for the preparation of grant applications, running research grants, editorships of journals and membership of grant awarding committees. We see this as essential to ensure that the time and energy required to develop new research directions and impact are available to staff.

Our areas of research excellence

Within SBCS we consider that we have six clusters of significant research strength. Within the biological side of the school we have four – Aquatic Ecology, Evolution & Genetics, Biological Psychology and Structural Biology & Photosynthesis.

Aquatic Ecology. We have arguably the strongest Aquatic Ecology group in the UK, recognised as a research highlight in RAE2008 and which has continued to grow during the REF period. Research stretches from molecules to the global biosphere and has the overarching vision to gain a deeper understanding of how biological systems respond to a changing environment, over ecological and evolutionary timescales. The group has well-established and innovative links to the Freshwater Biological Association (FBA) and the River Communities Group – a commercial venture that grew out of research conducted at QMUL. Since 2008, established staff working in the area (including **Trimmer**, **Grey** and **Hirst**) have been joined by the new appointments **Kratina** and **Harrod** who will strengthen the group's focus on food-web dynamics, while the appointment of **Eizaguirre** provides further connection to the Evolution & Genetics group via his work on genetic variation in fish. Major research achievements include: the formulation of a theoretical and experimental framework for quantitatively predicting the consequences of climate change; a paradigm shift in our view of production, or 'energy for life', in lakes and rivers; the discovery of potential new pathways in the cycling of the key bio-element, nitrogen (papers by **Trimmer, Grey** et al.); and new insight into global warming, oxygen and body size in aquatic organisms (**Hirst**).

The Evolution & Genetics group has one of the highest concentrations of evolutionary genomics researchers in the UK and has led on several significant internationally-coordinated genome assembly papers: **Wurm** (ants)**, Buggs** (birch), **Clayton** (zebra finch) and **Rossiter** (bats). It specialises in the ecological and evolutionary consequences of speciation and hybridisation, and leads in the application of next generation sequencing technologies (gene expression, comparative genomics, population genetics) to resolve patterns and processes associated with genome and gene divergence (Professor Richard Nichols, Dr Chris Faulkes, **Buggs, Leitch,** and **Rossiter)** and the evolution of social systems **(Wurm)**. For example they have shown that bats and whales show genome-wide signatures of sequence convergence associated with echolocation (**Rossiter**), and that genome restructuring following polyploidy in plants is astonishingly fast (**Buggs** and **Leitch**). **Wurm** leads an international consortium assembling and analysing ant genomes to address the question of social insect biology. During the REF period the group has led on multiple papers in Nature, Current Biology and PNAS, and has attracted independently funded research fellows funded by NERC (**Buggs**), Marie Curie (2 in the period) and the Leverhulme Trust (2 in the period). **Rossiter** has held a Royal Society University Research Fellowship throughout this period and was awarded an ERC Starting Grant in 2012. The group co-ordinates and participates in a Marie Curie ITN INTERCROSSING (Prof Richard Nichols, **Buggs**, **Leitch**). The group's research links to excellence in other research clusters; notably **Clayton's** pioneering genomics studies, which link to Biological Psychology, and **Bessant's** work on proteomics linking to Structural Biology.

Biological Psychology arose from an initiative in 2007 to develop the School's strengths in animal behaviour and cognition into a unique brand of psychology that is firmly embedded in biology, with innovative research focused at the interface between psychology (perception, cognition, communication and social life) and biology (genome, brain, ethology and evolution). The pioneer of this development in SBCS was **Chittka** and we have built on this area over the last 6 years to make it a major research strength in SBCS. Its drive is to build a world-leading group studying how environmental factors and biological mechanisms interact to underpin cognition and behaviour, blending both animal studies and human research. Internationally recognised research leaders such as **Chittka** and **Emery** have been joined by new appointments during the REF period including **Clayton, Mareschal** and **Pluess**, while **McElligott** has been transferred to a Teaching & Research contract on the strength of his research achievements. Despite its recent inception, the group has achieved remarkable successes, with an internationally competitive outputs exemplified by the publications of **Chittka**, **Clayton**, **Emery**, **Mareschal**, **McElligott** and **Pluess**. The division benefits from synergies with staff in the Department of Linguistics, the School of Electronic Engineering & Computer Science (supporting interests in communication, instrumentation and computation), and the Centre for Social and Community Psychiatry in the School of Medicine & Dentistry. These researchers collectively belong to the Research Centre for Psychology, which formally links behavioural and social scientists from across QMUL in the areas of applied psychology, computational psychology and linguistics, and several successful collaborations across School boundaries are already ongoing.

Structural Biology & Photosynthesis spans the divisions of Chemistry & Biochemistry and Cell & Molecular Biology. SBCS Structural Biology was highlighted in RAE2008 and we have maintained and invested in this area, complemented by the further development of a distinctive cluster of excellence in photosynthesis research. The group benefits from collaboration and sharing of facilities with the NanoVision centre in the School of Engineering and Materials Science. **Krauss** and **Nield**, whose achievements include the elucidation of structures of photosynthetic membrane protein complexes, exemplify the synergies within the group. Protein structural studies employing X-ray crystallography (**Krauss** and **Pickersgill**), NMR spectroscopy (**Pickersgill** and **Viles**) and single-particle electron microscopy (**Nield**) are complemented by studies that place protein complexes in the context of intact biological systems (membranes and cells), using thin-section and freeze-fracture electron microscopy (**Ruban** and **Mullineaux**) and fluorescence microscopy (**Mullineaux**) to probe the larger-scale interactions and dynamic reorganisation of protein complexes. Structural studies have given distinctive insights into complex biochemical pathways, the activation of G-protein coupled receptors, the supermolecular complexes in the photosynthetic membrane and have revealed the interactions essential for the virulence of specific bacteria (**Pickersgill**, **Krauss**, **Nield**). There have also been major advances in understanding protein misfolding in Alzheimer's and Prion diseases (**Viles**). In photosynthesis, there is a distinctive emphasis on the understanding of bioenergetic membranes: for example how the properties of the intact photosynthetic membrane control the regulation of photosynthesis (**Ruban, Mullineaux**). The recent appointment of **Duffy**, a computational chemist with a background in quantum physics, brings a new dimension to the group. His modelling studies on macromolecules and membranes link **Ruban's** work on photosynthetic light-harvesting to the work of computational chemists elsewhere in the School, and offers the potential for advanced dynamic modelling of macromolecular interactions, complementing and enhancing the work of our protein crystallographers. The appointment of Dr Lilia Milanesi (submitted to sub-panel B8) strengthens our focus on biological membrane structure and function through her work on bilayer membrane structure and dynamics, and provides a further link between the School's chemists and biologists. Her work on the three-dimensional visualisation of membrane disruption by amyloid fibrils directly complements the work of **Viles** on amyloid fibril structure.

c. People: i. Staffing strategy and staff development

Staffing strategy: Our recruitment strategy is based around the maintenance, development and strengthening of our distinctive clusters of research excellence. Recruitment of new staff (and associated investment in start-up funds) helps to strengthen our areas of research excellence, while the existing staff in these areas help to provide a productive and supportive environment for the new recruits. New academic staff recruited during the REF period include **Eizaguirre**, **Harrod** and **Kratina** to the Aquatic Ecology group, **Wurm** and Dr E. Clare to the Evolution & Genetics

group, **Duffy** to the Structural Biology & Photosynthesis group and **Clayton**, **Mareschal and Pluess** to the Biological Psychology group, with **Clayton** also contributing significantly to research effort in Evolution & Genetics. The recruitment of **Bessant**, an expert in bioinformatics and proteomics, provides significant expertise in research that relates to both Evolution & Genetics and Structural Biology.

Probation for newly-appointed academic staff: The standard probation period is 3 years, during which new staff are set 3 key targets: to apply for at least one project grant per year, and normally be awarded one project grant or the equivalent within 3 years; to publish as first or corresponding author at least 3 papers in top journals in the subject area and to complete the Postgraduate Certificate in Academic Practice. Probationers are allocated a Probationary Advisor who meets with the probationer approximately every 3 months. They receive advice and support for research funding applications (which must be internally peer-reviewed before submission) and with manuscripts and responses to reviewers. Pre-2011 they received modest start-up funding (typically £15-20K) but also free access to SBCS facilities and technical support whilst establishing their own funding. Since restructuring in 2011/12, start-up funds are far more generous, with the result that average start-up funds allocated during the REF period are about £74K for new staff in the Biological Sciences area. In addition, all new staff are now awarded a research studentship to start as soon as feasible after arriving at QMUL. Initial teaching loads are light (about 12-15 lectures in the first year, building up to a full load by the third year). Probationers are not allocated significant administrative duties.

Mentoring and support for academic staff other than probationers: Academic staff are line-managed by their Head of Division or deputy. Established staff are assigned on request a research mentor who provides advice and support for funding applications and publications. In addition, all grant applications valued above £50K are subject to a formal internal peer-review procedure that must be completed prior to submission. The appraisal system has been updated in the last year, with an annual meeting to formally compare performance against the targets that were set the previous year. During appraisal, all staff can request specific support for training, equipment or resources that will facilitate their work in the next year. The appraiser and appraisee meet on at least 3 other occasions during the year to review activities and ascertain in-year progress and development.

Support for postdoctoral staff: Research Fellows and Postdoctoral Research Assistants receive the same mentoring support as probationers. All postdoctoral researchers are offered the possibility to have a mentor, assigned from within SBCS, whose main task is to support staff in securing their career choices. Mentoring and peer review of fellowship applications has contributed to considerable success for the School in these schemes (during the REF period there have been 3 Royal Society University Research Fellows in the Biological Sciences area of the School, with 1 NERC Fellowship, 4 awards of Leverhulme Early-Career Fellowships and 7 awards of Marie Curie Fellowships). During the REF period, 4 staff have moved from research positions to permanent academic posts in the School: **Emery** and **Nield** from Royal Society Fellowships, **Buggs** from a NERC Fellowship and **Duffy** from an EPSRC-funded PDRA with **Ruban**. Further evidence of mobility comes from our research staff taking up senior fellowships and academic posts elsewhere: Dr Lu-Ning Liu from a Marie Curie Fellowship in the **Mullineaux** lab to a Royal Society University Research Fellowship at the University of Liverpool, Dr Matthew Struebig from a Leverhulme Early Career Fellowship to a lectureship at the University of Kent, Dr Matthew Johnson from a PDRA with **Ruban** to a lectureship at the University of Sheffield and Dr Nigel Raine from a PDRA in the **Chittka** group to a Readership at Royal Holloway, University of London. QMUL support for PDRAs includes a Science & Engineering Postdoc Network (established as part of the College's Concordat Implementation Plan) which was led by Dr Thomas Ings (an SBCS Leverhulme Early-Career Fellow who moved to a Senior Lectureship at Anglia Ruskin University). The network runs events such Postdoc Forums and Grant-Funding Masterclasses.

Equal Opportunities: SBCS strives for equal opportunities in all its appointments and treatment of staff. In September 2013 SBCS was awarded a coveted Athena SWAN Silver Award for excellence in recruiting and advancing the careers of women in science, engineering and technology (SET), marking the progress made in equal opportunities during the REF period (see Athena SWAN web-pages http://www.sbcs.qmul.ac.uk/79202.html). Since creation of the 4 new divisions in 2011, 40% (4 out of 10) T&R appointments in Biology have been female. We also appointed 50% female staff on T&S roles and the 3 fixed-term T&S lecturers are also female. We are supporting our female staff with 1 year

PDRA support around periods of maternity leave and are planning a number of beacon activities in our quest for the Gold Athena SWAN Award. Staff in SBCS have contributed to the successful College bid for Athena SWAN bronze, and act as School champions in the current College application for renewal. In addition, SBCS supported and encouraged the establishment of Women in Science and Engineering (WISE) at QMUL, which has been led by several of our research students (http://wiseqmul.wordpress.com/).

c. People: ii. Research students

Development of a research culture: Research student recruitment, supervision and progression is overseen by the SBCS Director of Graduate Studies (currently **Grey**). PGR students are an important part of SBCS research culture. They are integrated into research themes, participate in research events and are represented on the SBCS Research Strategy Group. SBCS promotes the involvement of research students in the wider research culture through seminars and symposia: a.) SBCS hosts research seminars by distinguished visiting speakers (e.g. recently Peter Holland, FRS; Lynn Margulis, Peter Lawrence FRS, Sir Tim Hunt, FRS, Colin Blakemore FRS, Wolfram Schultz FRS, Nicola Clayton FRS, Richard Gregory FRS, Nick Barton FRS, Lorna Castleton FRS, Neil Hunter FRS and Rienk van Grondelle FRDA) and research students are encouraged to attend these seminars and to interact with the speakers; b.) Specialist research mini-symposia; c.) An annual Postgraduate symposium, with talks by third-year research students and poster presentations by second-year students; d.) Research techniques in Biomedical & Life Sciences, a monthly series of afternoon training sessions run by SBCS staff in collaboration with Medicine & Dentistry which provides PhD students and PDRAs with opportunities to learn about the wide range of research techniques that are used by life sciences researchers throughout the College; e.) Specialist weekly meetings at which post grads and postdocs present a recent publication or research idea. At College level, the recently-established Queen Mary Doctoral College provides the focal point for supporting doctoral and postdoctoral researchers at QMUL, while the QMUL Centre for Academic and Professional Development provides a full programme of transferable skills training. A points-based training system supports delivery of QMUL's PGR training strategy, based on the RCUK-endorsed Vitae Researcher Development Framework. Science Communication training includes "Junk the Jargon", a College-wide competition where PhD students present their work to a public audience, This was won in 2010 by SBCS's Claire Sarell from the **Viles** group.

The excellence of our PGR students is evidenced by their high completion rates (see below) and also by the papers that they produce: 23 papers submitted to this REF assessment are authored by our PhD students. Examples of successful PhD students during the REF period are: Michelle Jackson who completed her Environment Agency part-funded PhD with **Grey**, took up a PDRA on the EU-funded RINSE project and is now a Fellow at the Centre for Excellence in Invasion Biology in South Africa. Gabriel Yvon-Durocher completed his PhD and PDRA (both NERC funded) with **Trimmer** before taking a Lectureship at Exeter. Elli Leadbeater completed her PhD with **Chittka** before going on to research fellowships at the University of Sussex and the Institute of Zoology, and a lectureship at Royal Holloway, University of London. Matt Struebig did his PhD in SBCS with **Rossiter**, before winning a Leverhulme fellowship to work here, then securing a lectureship at the University of Kent. Now he has won a multimillion NERC consortium bid with **Grey** and **Rossiter** under the Human Modified Tropical Forest Programme.

Research student progression and submission rates: Of the cohorts starting between 2008/09 and 2012/13, 94% (95/101) passed the progression hurdle at the end of their first year. Of students registered for Biology and Psychology PhDs and due to complete since 2008, 96% (80/83) submitted PhD theses within the 4-year deadline.

Research student recruitment: SBCS Biology research students enrolled during REF period are supported by studentships from BBSRC, NERC and EPSRC (respectively 9%, 19% and 2% of total), by School and College funds (mainly competitive College-funded studentships) (33%) and by other bodies including the EU (4%) Leverhulme Trust (2%) and China Scholarship Council (11%). SBCS Biology is involved in 3 Marie Curie ITNs (1 coordinated by SBCS staff) and played a leading role in a successful bid for a NERC Doctoral Training Partnership, in collaboration with a London-wide network of institutions. The London NERC DTP will recruit 120 research students over 5 years starting in 09/14. A bid for a BBSRC DTP involving the same consortium is in preparation. Numbers of new Biology/Psychology research students enrolled have been sustained at 16-24 p.a. during the REF period (24 in 2012/13 and 22 in 2013/14) and will be sustained in the future by involvement in all the above-mentioned RCUK and international consortia, plus Science Without Borders (Brazil) and industrial partnerships as detailed below. All short-listed applicants

must be interviewed by at least one senior member of academic staff who has no involvement in the supervision of the proposed project. Staff are required to record reasons for accepting and rejecting applicants for PhD positions and these recommendations are approved and signed off by the Director of Graduate Studies. Of the cohorts starting from 2010/11 to 2012/13, 50% are female. 53% are UK nationals, 35% EU and 12% overseas. 8% were aged 31+ at registration, with an overall average age of 26.

Procedures to stimulate and facilitate exchanges between academia and business

SBCS is supportive of CASE studentships and gives them high priority, to promote knowledge exchange and impact with stakeholders and industry. Staff have been very successful in attaining CASE support from a broad range of partners from the environment through to the pharmaceutical and agrochemical industries (10 new CASE awards in Biology during the REF period). Industrial and CASE partners in Biological Sciences include AXA, BatPro Ltd, the Centre for Ecology and Hydrology, The Freshwater Biological Association, g-Nostics, Highland Birchwoods/Trees for Life, the Macauley Institute, Natural England, the Natural History Museum, NuCana Biomed Ltd, Pfizer and the Zoological Society of London. CASE partnerships are an important feature of the new NERC DTP. There are specific QMUL Careers events for STEM researchers considering the transition from academia to industry, where QMUL PhD alumni speak about their careers outside academia.

d. Income, infrastructure and facilities

Research Funding: Overall new grant income (@100% FEC) awarded to SBCS since 2008 is £31.9M, of which £24.2M was awarded to staff in Biological Sciences. This compares with total grant income to the whole of SBCS of £16M during the RAE2008 assessment period. The near-doubling of grant income indicates a step-change in our ability to secure research funding during the REF period. Highlights include NERC grants to the Aquatic Ecology and Evolution & Genetics groups totalling over £6M to QMUL during the REF period. This included income from several NERC consortia, launched in response to national strategies (£6.5M in total). **Trimmer** leads one involving Imperial, York, Lancaster, Essex, & SAMS, in collaboration with **Leitch** and Heppell (QMUL, Geography), securing £3.4M of funding under the NERC Macronutrients Programme, while **Grey** (£430K) and Dr Iwan Jones (£638K) lead QMUL components of the £3M DURESS project under the NERC Biodiversity for Ecosystem Service Sustainability Programme. **Grey** and **Rossiter** are part of a £2.3M NERC consortium grant under the Human Modified Tropical Forest Programme. At the international level, European funding has been awarded to Prof Richard Nichols (€3.5M in total, >€1M to SBCS) as co-ordinator of a Marie Curie ITN programme, and to **Rossiter** and **Leitch** through the Marie Curie Fellowship programme. **Wurm** and **Rossiter** have obtained substantial BBSRC funding through the REF period, while **Buggs** moved to SBCS from the USA on a NERC Fellowship in 2010. **Rossiter** currently holds a Royal Society University Research Fellowship (2006 – 2014) and was recently awarded an ERC 5-year Starting Grant (€1.5M) for long-term research into the genetic basis of divergent and convergent evolution.

Highlights in Biological & Experimental Psychology include the award in 2013 of €3.47M (of which €2M to SBCS) to **Chittka** for an ERC Advanced Fellowship on radar tracking of foraging bees. **Chittka** also hosted 3 Marie Curie Fellows, while **Emery** held a Royal Society University Research Fellowship before taking up a permanent post in the School.

In Structural Biology and Photosynthesis, highlights include **Ruban** and **Mullineaux's** participation in a Marie Curie ITN. In addition, **Mullineaux** hosted a Marie Curie Fellow, **Mullineaux**, **Nield**, **Pickersgill**, **Viles** and others have all obtained substantial BBSRC funding in the REF period (total BBSRC funding awarded since 2008 is £3.75M), with EPSRC and Leverhulme Trust funding to **Ruban** and Carbon Trust funding to **Mullineaux** and **Ruban**. **Nield** moved from a Royal Society University Research Fellowship to a permanent post in SBCS in 2012.

Infrastructure & Facilities: Support for research activity within the School includes the development of a series of research facilities, each in the charge of a specific skilled facility manager or experimental officer. These facilities have benefited from substantial investment (particularly from CIF funding) during the REF period.

- An *Analytical Laboratory* supporting research in Aquatic Ecology as well as Structural Biology & Photosynthesis which is to be expanded into a separate laboratory for each area, with recruitment of an additional technician.
- *Confocal, Epifluorescence & Electron Microscopy* supporting research especially in Evolution & Genetics, Structural Biology & Photosynthesis and also Biological & Experimental Psychology through imaging of neural processes in animal models. We have invested in exceptional state-

of-the-art imaging (£610K, including epifluorescence microscopy with Openlab and Volocity imaging software, Leica confocal microscopy, including multiphoton capability and Imaris software for image reconstruction and quantification).

- *EEG and Eye-tracker* installed in the last year, as part of a £200k laboratory upgrade to support research in Biological Psychology.
- *Informatics Resources* supporting research especially in Evolution & Genetics. We have recently contributed to the Faculty's 3000 CPU High Performance Computer (HPC) which is part of the UK Grid, as well as in-house smaller clusters and high memory computers. In 2012 QMUL invested £500k in HPC to address the needs of modern genomics research (we now have two machines with each at least 512 gigabytes of RAM and 48 processing cores). These are primarily used by our evolutionary geneticists, contributing to their work on genome assembly, hybrid speciation, polyploidy, population genetics and evolutionary genomics.
- *NMR & EPR spectroscopy* supporting research in Structural Biology & Photosynthesis.
- *Protein Purification* (including cloning and expression) supporting research especially in Structural Biology & Photosynthesis. CIF investment includes Li-Cor Odyssey infrared imaging and molecular biology equipment (RT-PCR, phosphorimaging).
- *X-ray diffraction* supporting research in Structural Biology & Photosynthesis.
- *Zebrafish facility* supporting research especially in Biological & Experimental Psychology through the use of zebrafish as animal models for behavioural traits.
- *Category 3 Microbiology laboratory* (£422 K investment in the REF period) supporting biomedically-related research.
- CIF investment in Aquatic Ecology has enabled us to set-up one of the largest CO_2 flux monitoring facilities in the country, which has secured substantial further NERC funding and attracted novel support for PhDs (e.g. AXA Insurance funding). In the last two years the outputs from this unique field experiment have not only appeared in a range of high-profile primary research papers, but have been highlighted by Nature, the BBC, NERC's *Planet Earth* in-house journal and the UK Government/Civil Service *Public Services Review*.

We are currently refurbishing and reorganising the laboratory space in the SBCS buildings, with College investment totalling £9.3M in the G.E. Fogg building that houses the bulk of Biological Sciences activity. £4.3M (HEFCE and RCIF) was invested in re-cladding and renovating the exterior of the GE Fogg Building (for which we won a Green Gown sustainability award in 2011), and the College has now approved an additional investment of £5M for the next phase of refurbishment and re-organisation of the interior of the GE Fogg Building. In accordance with SBCS research strategy, the reorganisation will consolidate our research strengths by locating the laboratories, offices and shared facilities of the members of each research grouping close together, and wherever possible on the same floor. The construction of large, open research laboratories will facilitate flexible and efficient use of space and equipment, and help our research communities to exchange ideas and skills. SBCS technical support is also being restructured in line with the same research strategy. A technician will be allocated to manage each of the main research laboratories, while further technical support is focussed on the SBCS research facilities, with an experienced technician/experimental officer being put in charge of each facility. The College's Genome Centre (established in 2001 with £3.5M investment) provides a resource widely used by the Evolution & Genetics group as well as by our Medical School. Collaboration with the Medical School will be further enhanced through the College's proposed major investment in a new building to house the Life Sciences Institute on the QMUL Whitechapel Campus, projected to be opened in 2017/2018.

e. Collaboration or contribution to the discipline or research base

Local, national and international partnerships: At a local scale, there are interdisciplinary links with other sections of the College (for example with the Schools of Geography (NERC consortium grant headed by **Trimmer**), Engineering & Materials Science (shared use of facilities for electron microscopy and structural biology in the NanoVision unit), Physics**,** Mathematics**,** Electronic Engineering & Computer Sciences and Medicine and Dentistry). All these cross-disciplinary initiatives are encouraged by the College's Life Sciences and Materials strategies, by the award of interdisciplinary research studentships (7 during the REF period) and by a variety of pump-priming funds for interdisciplinary research (awards to SBCS ca. £50K p.a.).

Regionally, SBCS has strong links with several world-class research institutions in and around London, which are being built on in a new NERC Doctoral Training Partnership (with UCL, Birkbeck, Brunel, Institute of Zoology, KCL, Natural History Museum, Royal Botanic Gardens Kew

and RHUL). A comparable BBSRC DTP bid is in preparation. Current links with the Royal Botanic Gardens, Kew include 18 joint publications over the REF period, involving **Leitch**, **Buggs**, **Chittka** and others; 6 joint PhD students, and joint grants from NERC and the Centre for Ecology and Evolution. The Head of Kew's Jodrell Laboratory (Prof. Mark Chase FRS) is a Visiting Professor at QMUL, while **Leitch** is an Associate Research Fellow at Kew. Links with the Institute of Zoology include numerous joint PhD studentships and links with the Natural History Museum include a NERC Open CASE Studentship to **Grey** and joint publications. Links with Imperial College and UCL include joint grants to **Mullineaux** and **Grey**, while **Chittka**'s ERC funding establishes a major new link with Rothamsted Research. Further afield, there are productive links with the Centre for Ecology and Hydrology (NERC grant to **Grey**), the Lancaster Environment Centre (NERC grants to **Trimmer**), the Environment Agency (CASE studentships to **Grey**), the Centre for Environment, Fisheries & Aquaculture Science (DEFRA-led studentship involving **Trimmer**) the Freshwater Biological Association at Windermere and Natural England (CASE studentships to **Grey**). **Hirst** is Adjunct Professor at the recently established Centre for Ocean Life in Copenhagen. He co-supervises PhD students and Post-Doctoral researchers with Plymouth Marine Laboratory and the National Oceanography Centre, Southampton.

Formal international partnerships include involvement in 3 current Marie Curie ITNs (one of them co-ordinated from within Organismal Biology), and participation in the Canadian Institute for Advanced Research (**Clayton**). SBCS has close links with the Chinese Scholarship Council through the College's Memorandum of Understanding, and has entered into a formal partnership with Nanchang University (China) to deliver a Biomedical Sciences degree, enabling the recruitment of a new cohort of research active staff in Biomedicine. **Ruban** has links with Vilnius University (Lithuania) supported by a Royal Society International Joint Project Grant and resulting in 8 joint publications to date. **Trimmer's** collaboration with the University of Southern Denmark is supported by his NERC consortium grant, while **Grey** has links with the Oeschger Centre for Climate Change in Switzerland (RECONMET programme), the National Museum of Kenya (NERC grant), and the University of Jyväskylä, Finland (Finnish Academy project). Several staff have strong links with scientists based overseas that have resulted in papers in leading journals such as Nature journals, PNAS, and Current Biology. These include **Pickersgill** (with Lyon, France), **Krauss** (Karlsruhe and Berlin, Germany), **Rossiter** (Shanghai and Beijing, China) and **Leitch** and **Buggs** (Florida, US).

SBCS staff contribute to the wider development of their disciplines through membership of journal editorial boards and representation on funding body committees. We recognise and encourage such wider contributions through the allocation of time to these activities in our workload allocation model, which allows for trade-off of these activities against QMUL internal teaching and administration.

Editorial boards: Advances in Experimental Biology (Elphick); Animal Cognition (Emery); Antioxidants and Redox Signalling (Allen); Arthropod-Plant Interactions (Chittka); Biochemistry (Viles); Biochemical Journal (Viles); Biochimica et Biophysica Acta – Bioenergetics (Mullineaux); Briefings in Functional Genomics (Hurd); Comparative Physiology and Biochemistry (Elphick); Communicative & Integrative Biology (Chittka); Endangered Species Research (Rossiter); Freshwater Biology (Grey, Jones); Frontiers in Genetic Architecture (Hurd); Frontiers in Neurogenomics (Clayton); Heredity (Nichols); Journal of Bacteriology (Mullineaux); Journal of Plankton Research (Hirst); Journal of Zoology (Knell, Le Comber); MicroRNA (Hurd); Neurobiology of Learning and Memory (Clayton); Photosynthesis Research (Allen); Plant Physiology (Ruban); PLoS Biology (Chittka); Proc. Roy. Soc. Lond B (Chittka, Faulkes); Quarterly Review of Biology (Chittka); Trends in Plant Science (Allen).

Research Council and other funding body committees: BBSRC Research Committee C (Bessant, core member and Mullineaux, core member 2010-2012); BBSRC Research Committee D (Pickersgill, core member); NERC Peer Review College (Grey, Hirst, Jones, Trimmer); Slovenian, Romanian, Netherlands, Swiss, Polish and French Peer Review Colleges (Evans, Trimmer); ERC (Chittka, panel chair). Royal Society Research Grants (Chittka, Rossiter). Nichols chairs the steering committee for the NERC Biomolecular Analysis Facility.