Institution: Royal Holloway, University of London

Unit of Assessment: A5 Biological Sciences

a. Overview

Building on our success in RAE 2008, we have achieved all our strategic aims, resulting in a 50% increase in income, 22% increase in publications and 26% increase in graduate students. Research in the School of Biological Sciences (SBS) is intentionally diverse and ranges from molecular and cellular to organismal bioscience. It is structured into three centres: Biomedical Sciences (CBMS), Ecology, Evolution and Behaviour (CEEB), and Plant Molecular Sciences (CPMS). Each Research Centre has regular meetings to discuss priorities, new areas of development and funding strategies, future staffing, graduate student progress and good practice. Research Centre Leaders report to the School Research Committee, chaired by the Director of Research, which sets and reviews overall research strategy, productivity and resource allocation and reports to School Board, chaired by the Head of School. Graduate student recruitment and training is monitored and managed by the Postgraduate Committee, chaired by a Director of Graduate Studies, again reporting to the Board. Graduate students participate in the research culture through an active postgraduate committee, seminars, lectures, group meetings and workshops and representation on Research Committee and School Board. The School's performance in terms of grant income, publications and external engagement is monitored through a research information system (PURE) which informs Leaders of Research Centres, the Director of Research, Director of Graduate Studies and Head of School and at institutional level through Faculty and institutional Research Committees. Our primary strategic aim is aligned to that of Royal Holloway, namely to ensure that our research will be recognised throughout the world in being agenda-setting and meeting contemporary challenges. This alignment is achieved by strong links between the School, the Vice Principal (Research & Enterprise) and the Research & Enterprise Office and enacted through the Science Faculty Research & Enterprise Committee.

b. Research strategy:

Achievement of strategic aims during the REF assessment period

In RAE2008 we listed 5 key objectives, aimed at increasing research capacity in specific areas. We have fully achieved these through managed, strategic growth, utilising opportunities within Royal Holloway, nationally and internationally. Specifically, we have:

1. Expanded in the areas of neuroscience, development and gene therapy in CBMS, by appointing three new staff in neuropharmacology, developmental and neurobiology and a research officer in gene therapy.
2. Broadened our research in mathematical modelling and systems biology in CEEB with one new appointment in evolutionary theory.
3. Expanded behavioural and environmental ecology by appointing three staff in pollinator biology.
4. Expanded research in gene regulatory networks and food security in CPMS, by appointing two new staff in plant-pathogen interactions and a research fellow in seed science.
5. Established new links with collaborators and research users in research institutes and industry (for details see section e).

Our **key areas of strength** are underlined in the three Centre narratives below:

Staff in the **Centre for Biomedical Sciences** perform non-clinical research related to human health and disease. Areas of particular focus have been the development of new techniques and approaches for gene therapy in the treatment of genetically inherited diseases. This has led to novel gene therapy vectors, the generation of potential novel drugs for the hitherto untreatable condition Duchenne Muscular Dystrophy, seven patent submissions, and direct investment by several companies. Research on probiotics and vaccines has led to the use of bacteria as probiotics in food and the development of new oral vaccines. This research received more than £2M of funding from the MRC and EU, and has attracted investment by Boehringer Ingelheim, GSK and Probiotics International. It has led to a spin out company, Holloway Immunology, for vaccine development. A third focus is on neurological disorders. A new, non-sentient model for neuroscience research using the amoeba *Dictyostelium* was developed with funding from the National Centre for Replacement, Refinement and Reduction of Animals in Research (NC3R). This has led to discovery of a new treatment for epilepsy, a licensed patent, and investment by the

specialised nutrition company Vitaflo. Staff have published in *Nature Medicine, PNAS, The Lancet*, *The Lancet Neurology and PLOS Biology*

Staff in the **Centre for Ecology, Evolution and Behaviour** research how individuals and populations adapt and interact with each other and their environment. A major focus is on pollinator biology. This research has attracted over £1M funding through the Insect Pollinator Initiative and has shown that sub-lethal levels of pesticide affect bees' foraging. This has influenced the debate on bee decline and informed policy makers on the effects of pesticides on bees. Research on pollinators has also provided insights into social learning and the evolution of eusociality. The unit has strength in mathematical modelling, which has explained complex patterns in population dynamics, epidemiology and behaviour and evolution and genomic imprinting. A further area of strength is the research on changing communities in changing environments. Here, research has reconstructed the population dynamics of extinct species in response to climate, using ancient DNA analysis, while empirical and meta analytical work has demonstrated how current climate change can impact upon multiple trophic levels. Within this area, research on invasive species ecology provides example of outcomes that are not immediately visible. Examples include finding biological control methods for the invasive Chinese mitten crab, the Horse chestnut leaf miner and Himalayan balsam. Population dynamics of all these organisms only show trends over extended periods. Staff have published in *Science, Nature, PNAS, PLOS Biology and Ecology Letters*.

In the **Centre for Plant Molecular Sciences,** research programmes include both fundamental and applied research, the former, on model species such as *Arabidopsis*, aimed at informing work on crop species. Studies on crops have increased over the reporting period, to include tropical crops such as banana, plantain and sweet potato, as well as our on-going work on tomato and herbs. These have embraced the concept of 'sustainable intensification' to address global priority areas such as food security and biorefining. Research is focused on the generation of better crops, better foods and better seeds. This work has led to nutritionally enhanced tomatoes, and insights into the mechanism of seed germination and development. These areas have received funding through BBSRC, EU and industry funding programmes in excess of £5.5M. A further area of strength is research into signalling pathways and gene networks in plants which has revealed mechanisms underlying adaptation and tolerance to biotic and abiotic plant stresses and trade-offs in parasitism between plants and their pathogens. A third key area is the physiology of leaf and fruit growth in response to light. This has led to insights into how light influences gene expression in the regulation of the plant circadian clock and leaf formation and size. Staff have published in *Science, Nature Cell Biology, Plant Cell and EMBO Journal*.

Stimulating **interdisciplinary research** is an integral part of our strategy. We have, together with the Computer Science Department, founded a Centre for Systems and Synthetic Biology. This brings together researchers with various expertise in '-omics' technologies with bioinformatics and modelling from the two departments. The institution has provided the analytical and computational infrastructure through investment of £1M in mass spectrometry, genomics and computing facilities. The Centre fosters interdisciplinary research through the organisation of seminars, and enabling collaborative work in this area. Over £7M in RCI has been awarded for research in the area of systems biology to researchers in the two departments and has led to important insights into protein-protein interactions in fruits, seeds and bacteria.

Future strategic aims and research goals

We have developed a **robust research plan** that will maintain the key strengths and diversity across our three Centres. It overlays onto the Royal Holloway Research Strategy of agenda-setting on a global scale, and is sustainable and forward-looking. We have identified national and international priority areas to which we can contribute significantly and have developed the following objectives in our forward plan for the next five years:

1. Within CBMS, to further expand our interests in therapeutic techniques, in particular for genetic and congenital disorders, and seek to develop an international Centre of Excellence in gene therapy and translational medicine.
2. Within CEEB, to develop an international Centre of Excellence in pollination ecology.
3. Within CEEB to expand our interests in community responses and global change.
4. Within CPMS, to expand our research in food security, both nationally and internationally, and to apply our expertise in metabolomics and gene regulation to a more diverse array of crops, including cereals and the development of new renewable sources for biorefining.

5. To further develop links with establishments locally, including RHS Wisley, The Crown Estate, Royal Botanic Gardens (RBG) Kew, the Natural History Museum and BBSRC Rothamsted. To seek collaborative links with research institutes overseas, including those in South America, Africa and Asia.
6. To widen our biomedical research to encompass clinical aspects, we are developing links with local medical schools and NHS trusts, through joint appointments.

These aims will enable us to achieve our **research goals** for the next five years, which are to increase our income by 50%, to publish at least 600 high quality manuscripts, to increase postgraduate numbers by 30%, to develop at least one spin-out company and to increase our profile in external engagement by greater contribution to national and international policy decisions, including the key areas of human gene therapy, pollinator decline and food quality in the human diet. This will be achieved mainly by investment in new appointments.

We recognise the importance of **disseminating our research** and documenting the impact it has on society. We have appointed an Impact Officer to manage the **promotion of our research** and its outcomes in the future. Royal Holloway has appointed five Research Theme Champions, one of which is 'Health, the Human Body and Behaviour', led by Dickson (CBMS). This will promote our research, and will facilitate major new research initiatives. It will also enable us to collaborate more with departments of Psychology, Management and Geography at Royal Holloway.

We will take this plan forward through **capacity building**, and aim to develop two major infrastructural projects relating to our areas of strength. We will seek to raise funds from external donors to establish a new Science Innovation Complex that will house our Centre of Gene Therapy. The centre will house academics from the School, along with new appointments and will maintain close links with it. It will enable progression of our aim to further links with local NHS Trusts and will provide research accommodation for a critical mass of staff for future research projects. New staff will be appointed who will lead on the fundraising issues and coordinate the initiative. Our second major project is the construction of new glasshouse facilities, costed in the region of £1M. The need for such a facility is supported by Royal Holloway and is an accepted part of the institution's Strategic Plan for the Estate. This facility will greatly increase our capacity to deliver on projects that cover food security, pollinator decline and changing populations. To ensure that our analytic and imaging facilities are **sustainable**, we have a clear access charge system that will enable future upgrades or replacements. We will apply to renew the successful BBSRC DTP we are engaged in, and are a partner in a NERC DTP together with other London institutions. We also will seek to enhance our intake of RCUK CASE students by focusing in our areas of strength, aligning these with applications to studentships that are provided by Royal Holloway.

c. People, including:

i. Staffing strategy and staff development

We aim to appoint top class researchers, who will maintain the vitality of our research as well as the curriculum we offer to undergraduate students. Our **staffing strategy** is informed by our research goals, and its success is shown by the seven new appointments during the assessment period (section b). Our staff structure is **sustainable** because our policy is proactive, not reactive. A School Plan is submitted each year, that anticipates forthcoming retirements. Before an existing member of staff retires or leaves, a group formed of the Head of School, Directors of Research, Teaching and of the three Research Centres meets to decide on the area of interest for a replacement. We do not seek to replace like with like, but make decisions that are informed by national and international research priorities and the demands of the curriculum. We ensure that start-up costs appropriate to the nature of the appointment (usually between £17 - £50K) are budgeted for, and will improve facilities if necessary so as to make these decisions sustainable.

All new staff must attend an **induction** course, introducing them to the mission and objectives of Royal Holloway, its values and philosophy, and operational matters. Subsequent workshops on Royal Holloway procedures are attended, and supported by an Induction handbook and online guidance. All professorial appointments are subject to scrutiny and reference by a panel of external advisors, encompassing University of London, other UK and international universities.

All new **early career** (research and academic) staff normally have a probation period of three years, during which they are set specific targets to meet, pertaining to research income and output.

They are given additional support and guidance by senior staff in the School and a lighter teaching and administration load, facilitating a successful start to their research careers. A probation adviser is appointed by the Head of School, who will meet with them at least four times a year, whilst a College Probation Committee reviews progress annually. PDRAs have shorter probation periods.

We recognise that new staff must be good teachers as well as high class researchers, and Royal Holloway offers a Postgraduate Certificate in Academic Practice in Teaching and Learning (CAPITAL). Completion of this programme is a standard probation condition for new lecturers, though exemption may be given if a similar programme has been completed in a previous institution. CAPITAL is accredited by the Higher Education Academy (HEA).

Senior staff act as mentors to mid-career and new professorial staff. Once probation has finished, all staff are subject to a well-established annual appraisal scheme. **Appraisals** are conducted by the Head of School and the Leaders of Research Centres, while academics conduct those for their research assistants. All staff prepare a personal research plan, in which work objectives, including research and teaching, are set for the following academic year. Training and career development needs are identified at these appraisals and longer term career goals are set. During the REF assessment period, the School has introduced a **workload model** which includes the teaching, administration and research tasks of our staff. Annual returns are used in staff appraisals and to guide decisions by the Head of School in the allocation of duties.

Royal Holloway actively endorses the seven principles outlined in the ***Concordat to Support the Career Development of Researchers*** and has policies and practices at both institutional and School level designed to facilitate full implementation of these principles: The university has established a development programme for staff called 'On Track'. This consists of a series of 15 **workshops**, open to researchers at any stage in their careers whether fixed-term or permanent. Workshops are led by a mixture of external facilitators and internal experts, and are tailored specifically to science disciplines where appropriate. During the assessment period, seven SBS staff have attended the programme. The School runs a successful **mentoring scheme**, in which senior staff act as advisors on all aspects of research to early career researchers. This provides an excellent platform for the development of research careers and integration of early career and fixed-term staff into the research culture of the School and in the wider (outside of the university) context. The Library and Computer Centre provide training workshops and on-going support in the use of all the major software packages and the School has a policy to send researchers off-site for specialist software training, if the need arises.

The School is also a member of *Open*, a collaboration between Royal Holloway and King's College, which provides early career (fixed-term and permanent) researchers and research students with a platform to support the initiation and delivery of their own - possibly their first - **collaborative projects**. The programme consists of a comprehensive package of training, support and funding advice for future research stars. Further examples of implementation of the Concordat include mandatory training for all members of selection panels (including equal opportunities training), equitable treatment for part-time and fixed-term staff, and a clear and equitable promotions process. Extensive staff development opportunities are offered, including a centrally administered mentoring programme, supplemented by the School mentoring for early career staff, described above. Furthermore, there is a comprehensive annual equality and diversity data monitoring and review exercise.

The School has a policy of encouraging **sabbatical leave** applications and over the assessment period, 42% of staff have taken a sabbatical. Staff are entitled to apply for one sabbatical term for every 8 terms of service. Reports on sabbaticals are monitored by the Research Committee. The policy has been extremely successful in enhancing and/or re-invigorating research careers and the average output from sabbaticals has been six manuscripts and two major grant applications submitted from each sabbatical.

We are committed to the principles of **equality and diversity** amongst our staff. Royal Holloway is recognised globally for its international outlook and the School is no exception, with staff of 13 nationalities represented. We are delighted to say that over the assessment period, the proportion of female academic staff in the School has trebled, from 6 to 19%. Royal Holloway has a Women in Science (WiS) Steering Group, supported by senior management, which has overseen the

implementation of a WiS Action Plan 2010 – 2013. This is focused on promoting gender balance in a wide range of areas including flexible working, promotions, equal pay, recruitment and selection, childcare, probation, mentoring, communication, networking and profile. The School is represented in this group, enabling good practice to be developed and actively promoted in many areas e.g. maternity leave, and recruitment policies. Royal Holloway achieved Athena SWAN Institutional Bronze status in July 2010 and currently the School is working towards Athena Departmental Bronze status.

ii. Research students:

Applications and recruitment to PhD programmes have been buoyant and there has been a 26% increase in the number of doctoral degrees awarded in this assessment period compared to the previous. Our intake has roughly equal amounts of RCUK and institutionally funded studentships, complemented by a fraction of other funding sources (e.g. EU, charities and self-funded). Our postgraduate community is well integrated into the Research Centres and is dynamic and diverse. During the assessment period, we have had postgraduates from 30 different countries study with us. There are robust support procedures in place in Royal Holloway for the welfare of overseas students. There are programs for English language support and e-learning modules available to help improve reading, writing, critical thinking and note-taking skills.

Once a student has started the PhD, the majority of **research training** takes place in the supervisor's laboratory overseen by the academic. All students are allocated an additional academic as advisor, even for jointly supervised projects. Advisors provide scientific and pastoral advice and will take over supervision if the supervisor falls ill. The supervisor(s) and advisor conduct annual reviews with the student. Students may attend workshops in the UK and overseas to acquire specialized skills, as necessary.

All students are required to present their research in poster and oral form in a formal internal setting at least once each year during their PhD study. In addition, all students are expected to attend a number of conferences to present their work. The precise number varies depending on discipline, but all students attend a minimum of one national conference and one international conference during their period of study.

To complement the scientific training we run a transferable skills programme following the Vitae Researcher Development Framework. The Royal Holloway **Generic Skills Programme** (GSP) delivers and monitors the generic and transferable skills training for postgraduates. Attendance at all skills workshops is registered and a transcript describing these is provided on completion of the PhD. The total training provided at GSP and School level occupies the equivalent of at least two weeks per year, and is designed to suit the student's level of progression. The core courses cover the following key areas: Personal and Research Effectiveness; Presentation and Communication Skills; Statistics and Writing Skills. The list of optional courses includes Business, Enterprise and Commercialisation Skills courses; Information Skills and Careers courses, and courses designed to help in completing the PhD. The GSP also organizes academic (combined with social) activities designed to bring students together in an interdisciplinary environment. There is no upper limit on the number of days of generic skills training that a PGR student can undertake during the course of their degree.

To facilitate the **research student culture**, each Research Centre holds weekly informal meetings for students and staff, organised and run by one of the postgraduates. A variety of activities, such as practice presentations, discussion of controversial or recently published manuscripts, discussion on data analysis/presentation or advice with funding applications feature in these. Each is followed by optional social activities, all of which are designed to sustain an integrated and vibrant community feeling amongst the postgraduates. More formally, there is an annual postgraduate symposium of talks and posters, with prizes, invited speakers and a School social event at the end. Feedback is given by the collation of marks and comments on each talk, provided by all members of the audience (i.e. staff and students). The postgraduates are given the task of seeking external sponsorship for the event and attracting trade exhibitors to a small exhibition. This is remarkably successful and enables them to understand how external funds may be sourced as well as meeting representatives of potential employers. Postgraduate students are also expected to attend the weekly School research seminar series, given by external speakers, and their attendance is

monitored as part of the training programme. Overall quality monitoring of the postgraduate provision is performed by the Research Committee using data from the Postgraduate Research Experience Survey, run by HEA.

The School has gained 10 **competitive CASE studentship awards** over the assessment period, from NERC and BBSRC. CASE partners vary from large companies (e.g. Syngenta, GlaxoSmithKline, Boehringer to SMEs (e.g. Symbio Ltd, Surrey) and also include research institutes (James Hutton, Forestry Commission, Soil Foodweb Laboratory, Laverstoke Park). Successful outcomes include a study of green roof design for enhancing urban biodiversity by Chloe Molineux (NERC). The technology developed is now applied in a green roof consultancy and installation business, set up by Molineux. Meanwhile, Daniel Rickett (BBSRC) worked on the polyphenol content of wild tomato relatives and is now employed as a research scientist with Syngenta, the CASE partner.

d. Income, infrastructure and facilities

We have diversified our **research income**, with a 13% increase in the number of funding agencies per year which now includes, apart from RCUK, a range of 3rd stream industrial partners, EU, UK and overseas charities, overseas governments and research organisations and a wide range of UK governmental and non-governmental organisations. Through this diversification we have achieved an **increase in overall research income** of 50%, from an average of £2.1M per year over the period of RAE2008 to over £3.1M p.a. over this assessment period. Income has increased through two main developments: firstly, we have increased the impact of our research by carefully considering applications and working with stakeholders and end users at all stages. This has resulted in increased involvement of industrial collaborators, which has increased by 300%. Secondly, through responses to national and international priorities and initiatives, we have successfully won a number of large research contracts. Over the assessment period, our staff have been awarded £1.2M funding by the BBSRC Insect Pollinators Initiative (a £10M consortium of UK funders for research into factors that adversely affect insect pollinator populations) and the global partnership for a food secure future (CGIAR) funded research to a value of £0.5M in response to an initiative for work on roots, tubers and bananas. A further £5.7M of EU funding has been won, of which there is £2.1M under the ERANET initiatives for plant genomics and systems biology. Several Framework 7 initiatives were coordinated by our unit. An indication of our upward trajectory is shown by two recent EU grants to the value of £2.5M being won since August 2013.

The **research infrastructure** in the School has improved considerably over the assessment period, and now clearly reflects the focus of our research strengths. An excellent team provides technical and administrative support for research. Large research groups have institutionally funded technician posts. The School possesses state-of-the–art facilities for molecular biology, metabolomics and imaging, as well as a dedicated Biological Services Unit which supplies material and services for our biomedical research. There has been substantial investment through the last CIF round, wherein mass spectrometry facilities (£545k) have been purchased for research in proteomics and metabolomics, together with an investment of £250k in a suite to support research in analysis of genomic data and systems biology. To analyse the data and support the modelling, an investment of £123k has provided a computational facility, which gives superb computational power. Three appointments in this thematic area have been made (1 chair, 1 senior lecturer and 1 PDRA funded through the institution) to capitalise on these facilities. The School has a dedicated budget for research infrastructure and has continued to invest in its basic facilities, maintaining and upgrading Constant Environment Rooms, Biological Services Unit, marine and freshwater aquaria, flow cytometry, advanced microscopy and imaging facilities, outside field trials, glasshouse and polytunnel space.

Royal Holloway provides a number of central facilities – e.g. library, computer centre, careers centre, PG social space and a Senior Common Room. The School has a relatively large budget (£850K) for library and IT support, which includes purchase of software, on-line resources and electronic access to a large number of journals. Looking forward, Royal Holloway has recently instigated a capital fund to sustain and improve research infrastructure across departments. Through this scheme the School has purchased a Nikon NiE Upright microscope, to further enhance the imaging facilities. This will benefit staff across the School, particularly in CBMS and

CPMS. Royal Holloway has also provided £400k to refurbish the building that houses the School, in 2012-13 and is investing £35m in a new 10,000m^2 library building, with 24/7 access, dedicated postgraduate research spaces, and IT infrastructure, able to meet current and future digital demands. It is scheduled for completion during 2015.

We have secured a number of **in-kind benefits** from companies and research institute partners, in the form of field trials space, soil food web analyses and plant growth facilities, oligonucleotides and testing of novel pharmaceuticals by the US Government-funded Office of Translational Research. We have made extensive use of in-kind benefits through the NERC Radiocarbon dating facility, providing essential chronological control for a range of projects, but principally work on Late Pleistocene small and large mammal fauna.

Research governance within the School is overseen by the Head of School and Research Committee and our code of conduct is disseminated to all staff via the Staff Handbook and Royal Holloway web site. We provide access to the RCUK Policy and Code of Conduct on the Governance of Good Research. Any research that involves ethical approval must be scrutinised by the institutional Ethics Committee prior to application for funds. The avoidance and consequences of unacceptable research conduct, such as fabrication and plagiarism, form part of the training process for postgraduate students. The importance of keeping accurate records, stewardship of data, deposition in national collections or archives and the duty of care towards others (e.g. through the peer-review process) are key components of postgraduate and early career researcher training.

Within the institution, governance is overseen by an active Research and Enterprise Department (R&E) who have allocated a full time Research and Business Development Manager to the School. She assists with activities such as enhancing and diversifying sources of research and contract income from grants, consultancy, licensing, research sponsorship to spin-outs, identifying new funders, approaching lesser known sources of funding, building a research consortium, calculating the costs of the project and the price for the work as well as dealing with industrial funders and partners. R&E also negotiate contractual terms and agreements, assist in seeking finance for commercial projects, arrange input from specialist consultants, if necessary, and arrange for intellectual property protection where appropriate. R&E also provide support for the development of large research consortia and EU grant proposals. They provide sponsorship to enable departments to invite potential collaborators, funders and stakeholders to Royal Holloway for workshops, aimed at establishing partnerships in research. Examples of recent events hosted by the School (and which have led to applications and funding) include a day on *Long-term ecological experiments* (co-organised with the Ecological Continuity Trust), involving partners from other universities and organisations including Natural England, and also meetings with staff from BBSRC Rothamsted, RHS Wisley and the Horticultural Development Council.

R&E administer a Research Strategy Fund which is specifically designed to provide pump-priming for projects and is particularly useful for new academics or those seeking to develop new lines of enquiry. The School contributes a minimum of 10% to each project and during the assessment period, 95% of applications by staff in the School have been successful. R&E assist with all aspects of pre- and post-award finances and research governance.

e. Collaboration and contribution to the discipline or research base

Our research strategy is outward-looking, encouraging **collaborative ventures** at project level, wider dissemination and engagement in policy agendas. Staff have engaged in numerous projects with partners in other institutions. Most notable are the interactions and collaborations in funded international consortia. Our staff coordinate, or have coordinated, the EU programs INNOVAC, METAPRO, COLORSPORE and CDVAX and are, or have been, part of MULTIBIOPRO, SHIPREC, SKIP NMD and vSEED. Other **effective collaborations** include work with the School of Geography, Earth and Environmental Sciences at the University of Birmingham. This project concerns the conservation of old orchards and the rare insects within them. We provide input on insect ecology while Birmingham research the political, social and landscape ecology aspects of these habitats. Other examples include a range of projects on faunal response to climate change. These involve archaeologists (Bournemouth university) and Geographers at Royal Holloway on Late Pleistocene lemming populations; paleoanthropologists in Madrid on end-Pleistocene European brown bear dynamics; and archaeological chemists (Cambridge) and geomorphologists

(Trinity College Dublin) on polar bear origins. Others have worked with food scientists on projects funded by the Food Standards Agency for the detection of chicken in mechanically recovered meat products, using a proteomics approach. Meanwhile, a number of researchers in CBMS have worked with researchers in Institutes or Departments of Medicine to examine issues pertaining to human molecular genetics.

We have jointly supervised PhD students with CABI Bioscience staff, The Royal Horticultural Society, Animal Health and Veterinary Laboratories Agency (AHVLA) in Weybridge, the James Hutton Institute, the Forestry Commission (at Alice Holt), RBG Kew, and Syngenta. There have been major improvements in our collaborative arrangements with other research institutes, both locally and nationally. The interactions through the South West Academic Network (SWan) with St George's (UoL) and Kingston University have been highly beneficial through the provision of joint PhD studentships. This arrangement is now beginning to produce collaborative research outputs and proposals to BBSRC and MRC between Royal Holloway staff and the other SWan partners. A MoU has been signed with the AHVLA and CABI Bioscience.

The unit has hosted 11 Research Fellows (NERC, Leverhulme, Marie Curie) over the assessment period. We have won awards from the British Council, and research councils in Vietnam and India, and from Boehringer Ingelheim and Merck SD for vaccine development work and the Gates Foundation and Boehringer for muscular dystrophy work. The School also has strong collaborative links with other departments at institutions in the UK, including Imperial College London, The Natural History Museum and the MRC Research Complex at Harwell, through our participation in BBSRC and NERC Doctoral Training Partnerships. International collaboration is also demonstrated by the number and diversity of EU-funded projects in the School, that during the assessment period include over 100 other departments across Europe.

We have a policy to contribute strongly to the **support of research** exemplified by membership of the NERC Peer Review College continually throughout the assessment period. Meanwhile, we have members in the BBSRC Pool of Experts, and non-UK grant awarding panels, including European Research Council, Flanders Research Foundation, EU 7th FP panels, *Food, Agriculture and Fisheries*, and *Biotechnology and Health Innovation*, EU *Marie Curie Actions LIFE panel,* Medical Research Committee, Muscular Dystrophy Campaign, EU/US task force for Plant Biotechnology and the International *Dictyostelium* Advisory Board.

We also have a strong commitment to support the **dissemination of research** and during the assessment period, staff have acted as editors-in-chief of *Phytochemistry, Journal of Helminthology Journal of Nanobiotechnology* and *Journal of Stored Products Research*. Staff of the School are or have been members of the editorial boards of: *Basic & Applied Ecology, Biochemical Journal, Biology Letters, BMC Plant Biology, Conservation Biology, Current Bioinformatics, Ecological Entomology, F1000, Human Gene Therapy, Insect Conservation & Diversity, Insectes Sociaux, Journal of Experimental Botany, Journal of Evolutionary Biology, Journal of Theoretical Biology, Journal of Zoology, PLOS One, Proceedings of the Royal Society Series B, Oecologia, Planta, Seed Science Research and Soil Biology and Biochemistry*.

Staff have also made a number of contributions to **Governmental policy** through their research, including presentations to all-party parliamentary groups: Alternatives to animals in science (2012), Agroecology (2013), neonicotinoid pesticides and bees (2013), and the Scottish Parliament for Muscular Dystrophy treatment (2013). In the wider community, staff have also acted as consultants to a variety of bodies and companies. Examples include Brown (to Natural England, on bumblebee species re-introductions), Cutting (to 11 separate pharmaceutical companies, including GSK Belgium and Probiotics International), Dickson (to Silver Fern Research on gene therapy techniques and to Infonetica for development of an on-line course in Good Clinical Practice) and Leubner (to Buhler AG, Switzerland for seed biology). All of these have again reflected our research strengths and were in response to **national and international** governmental research agendas, including pollinator decline, food security and gene therapeutic techniques. One of the most important and exciting **research contribution to the discipline** has been the establishment of a spin-out company from the laboratory of Cutting, Holloway Immunology (http://hollowayimmunology.co.uk/). Its mission is to deliver innovative needle-free vaccines.