Institution: Oxford Brookes University

Unit of Assessment: 5 Biological Sciences

a. Overview

This submission comprises 24 researchers from the Department of Biological and Medical Sciences (BMS) plus three Primate Biology researchers from the Department of Social Sciences. The Biology researchers are organised into five main groupings: Plant Science, Evolutionary Developmental Biology, Cell & Molecular Biology, Biomedical Science and Primate Biology, with individual research groups residing under the umbrella of one of these generic headings. Two environmental biology researchers from the Department of BMS will join the University's submission to UofA 17.

During the REF period the University has undergone restructuring to create four faculties along with the dissolution of the existing eight Schools. Under this system a new Department of Biological and Medical Sciences was formed from the School of Life Sciences by the relocation of Nutrition and Sports Science staff to a new Department. The result, in research terms, was the formation of a more coherent unit of biological sciences researchers, the majority of whom are represented in this submission.

b. Research strategy

A key feature of our strategy as documented in the 2008 submission was to increase both the quality and quantity of our research. This has been achieved by investment in quality staff (27 returned here, 13 in 2008), expansion of our Research Fellowship scheme, targeted placement of PhD studentships, laboratory refurbishment, equipment replacement, and the establishment of a new Department of Biological & Medical Sciences resulting in a smaller more coherent collection of research groupings. Over the past 5 years we have concentrated research into two major areas, Molecular, Cell and Developmental Biology (incorporating plant science, developmental/ evolutionary biology, cell biology and biomedical research), and the newly established Centre for Ecology, Environment and Conservation (CEEC), which encompasses all our more ecological and environmental research, some of which is submitted in UofA 17. Research strategy is developed through research sessions at Departmental away days, which are inclusive of lecturing staff, research fellows, postdoctoral researchers and support staff, and is ratified via Faculty and University Research and Knowledge Exchange Committees. Departments hold regular formal meetings, and informal lunch meetings open to all members, including technical staff and PhD students, where research issues and strategy are routinely discussed. As detailed later, the University has invested significantly in biology research infrastructure through both laboratory refurbishment and equipment replacement.

Research activity is overseen by a Departmental Research Lead - a Senior Professor - and is supported by a Faculty Research Office with research administrators, a grants officer and research student administrator who collectively support the Faculty Associate Dean of Research and Knowledge Exchange, the Departmental Research Leads and the postgraduate tutor teams. The University's Research and Business Development Office offers support in funding opportunities and exploitation of research outcomes, including consultancy contracts.

We ensure that our research contributes to the student experience through a research-led curriculum and by providing students, where appropriate, with the opportunity to gain and practice a range of research skills. Undergraduates regularly work with research teams on both a voluntary basis and through funded scholarships during vacations and project placements.

A key feature of our current research strategy is to encourage all staff to take part as far as possible in public engagement activities. To promote this the Faculty has appointed the University's first ever Research and Science Communications Fellow**, Osterrieder**, whose role is not only to run an independent research programme but also to co-ordinate all outreach activities. These include the annual Brookes Science Bazaar, interdisciplinary partnerships between sciences and humanities, events for the 'Amazing Acts' Festival at the Pegasus Theatre, 'CSI Oxfordshire' where PCR equipment and activities are loaned to Schools and internal public engagement training sessions. She also runs online public engagement training workshops for researchers across Oxford Brookes, the Society of Experimental Biology and the Royal Microscopical Society. **Runions** has a weekly science spot on Radio Oxford as Dr Molecule explaining "current hot topics" to a general audience.

Future strategy is to consolidate on the expansion of research activity and number of research

active staff achieved over the last 6 years and to complete the refurbishment of Biology research labs. Over the next year the three primate researchers will become core members of the CEEC to expand its international remit and profile. We will continue to use QR and Royalty income streams selectively by investing in PhD students, start up support for new staff, pump priming new initiatives and expanding our successful Fellowship scheme in the fields of cell, molecular and developmental biology plus the CEEC.

c. People, including:

i. **Staffing strategy and staff development**

It is policy to recruit academic staff who are research active or who have considerable research potential. All new members of staff join one of the major research groupings and are assigned a mentor during their first year. They are also mentored in research management and research supervision training through attendance at the University's Research Management Training and Supervisor Training Courses as part of the University's "Your First Three Years" policy. These focus not only on University procedures for managing projects and postgraduate students, but also on project design and management, proposal writing, data management, IP, knowledge transfer, ethics and GLP. Topic-specific training is also organised at Department and Faculty level by the Faculty Research Training Coordinator. Progress is monitored via annual personal development reviews (PDR) with Programme and Research leads. All new research active staff are awarded start-up funds of between £5K and £10K, lab space and help with purchase of items of equipment where necessary. All contract research staff, research fellows and early career researchers are encouraged to attend the same training programmes as academic members of staff and again, progress and development are monitored and mentored via annual PDR reviews. Researchers have representatives on both Faculty and University research committees. Diversity and equality is promoted in all aspects of the recruitment and career management of researchers and the University The University conforms to the Athena Swan Charter and recognises and celebrates good employment practice for women working in science, engineering and technology (SET) in higher education and research. The University was awarded the Bronze Award in April 2013 and the Faculty is now working towards a Silver 'departmental' award.

The University runs a workload planning scheme whereby new research staff are allocated generous research time allowances in their first few years of employment. Research success in terms of grants and contracts funded, combined with production of high quality output also results in the award of generous research time allowance. All staff plan their research against a personal rolling 5 year strategic plan.

The Faculty runs a Research Fellowship scheme funded by QR and royalty income, where we identify (both internal and external) outstanding postdoctoral researchers with a view to promoting them to permanent lectureships. For example **Runions** who held a Fellowship in Plant Cell Biology was subsequently appointed to a Senior Lectureship and recently promoted to Reader, and **Vaughan** won a Fellowship in parasitology and was subsequently promoted to a Senior Lectureship. Both researchers have won BBSRC New Investigator awards. Currently we run four senior fellowships in virology, plant cell biology, plant pathology and metabolic modelling plus one Leverhulme Junior Research Fellowship and two short-term junior fellowships. Bridging funds are available to fund researchers between contracts.

ii. **Research students**

Departments recognise that the life blood of a healthy research environment is an active cohort of research students. Due to the sector-wide reduction in Research Council funded studentships, the Faculty invests considerable funds from its own royalty income stream to fully support a number of internal studentships, the majority of which are awarded to BMS (currently 16). Thus, this Department has a healthy cohort of PhD students, averaging 44 FTE which are also funded by a number of other income sources including Research Councils, Marie-Curie ITNs, industry and self-funded full- and part-time students. CASE studentships have been supported by the MRC and BBSRC. All research students are members of the University Graduate College and the Biology Doctoral Training Programme, which is headed by the Department Postgraduate Tutor and a Deputy who is also in charge of postgraduate training as well as researcher training in the Faculty. Supervisory teams consist of Director of studies, second supervisor and further supervisors where necessary, who are often external to the Department. All supervisors are required to attend a supervisory training programme, whilst all research students undertake a structured three year

training programme monitored annually via a training diary. This comprises Departmental and University-wide courses and events including an annual Grad. School, safety training, presentation and writing courses, introductory teacher training, plus topic specific training. All students are also trained as Science Ambassadors by Science Oxford, a local science outreach charity. All research students, FT and PT, are required to present a talk one year and a poster another at the annual Faculty postgraduate symposium, which is attended by all staff and researchers in the Department, and to present a formal Departmental seminar in the weekly seminar series. The latter is also organised and hosted by research students, who also obtain external sponsorship. There is a University-wide postgraduate society that holds a variety of events and supports the research student community and an on line Postgraduate Village within the Faculty that is run by and for research students and researchers.

Research groupings, activities, rationale, how they operate and main achievements
Research groups vary in size and tend to work in clusters with regards to lab meetings and journal clubs etc. For instance **Breuker** and **McGregor** run a bi-weekly Gene regulation club open to all researchers in the Department. The Plant Cell Biologists meet weekly and also run separate group meetings.

Plant Science: Plant science research is divided into two groupings.
The Cell Systems Modelling Group of **Fell** and **Poolman** centres on the computer simulation of metabolism, the prediction of the properties of metabolic networks and the theoretical analysis of metabolic control and regulation. They are concerned with studying how biological function arises from the interactions between many components, by building theoretical models that are tested with experimental results. They develop and apply theoretical tools, including metabolic control analysis, computer simulation and other forms of algebraic and numerical analysis. They are investigating how to decipher and process the metabolic information contained in genome sequences. A review of metabolic models of the Calvin-Benson Cycle (Trends in Plant Science 2011 (16) 676) compared the relative merits of 14 models. The model developed by **Poolman** and used as the basis for a number of publications was rated first for its suitability for metabolic engineering studies, and second overall. Current projects have goals that include improving plant and algal productivity, analyzing the metabolism of a microbial pathogen, and altering microbial metabolism to make biofuels. Having built the first genome-scale model of the metabolism of a plant, *Arabidopsis thaliana*, based on the enzymes encoded in its genome, they have just completed an even more detailed model of the rice plant. They are part of a European project to study and model the development of tomato fruit, in order to understand how metabolic changes affect fruit size and quality, and are also studying the links between the genes, metabolism and pathogenicity of salmonella with the aim of finding new ways of preventing infection. Funding has come from a number of sources including 7 BBSRC awards and a Marie Curie ITN.

The Plant Cell Biology Group, works on the structure and function of the endomembrane system. **Graumann** has established that the protein network including SUN and KASH domain homologues at the plant nuclear envelope is the potential linker between the chromatin, the inner nuclear envelope, outer nuclear envelope and the cytoskeleton. Various international collaborations support this research. She has also isolated novel nuclear envelope proteins and is funded by the Leverhulme Trust. **Runions** works on the interactions of the actin cytoskeleton, the plasma membrane and the cell wall. He has demonstrated a link between the actin-binding formin proteins and the cell wall and made the novel observation that plasma membrane protein dynamics are governed by the physical environment determined by the presence of the cell wall. His group was the first to describe single molecule imaging of proteins on the plant plasma membrane, work that was funded by 2 BBSRC grants. **Hawes** and **Osterrieder** work on the Golgi apparatus and endoplasmic reticulum. They have shown that the ER is shaped by membrane-embedded reticulon proteins, and that laser tweezers can be used to demonstrate ER-Golgi interactions and ER dynamics. This work has confirmed that the ER is physically attached to the Golgi and has revealed the role of tethering proteins at the ER/Golgi interface. Future work of the group will concentrate on identifying new proteins of the endomembrane system, their role in shaping the system and their dynamics in membranes. Research has been funded by the Leverhulme Trust, 3 BBSRC grants, the EU and 2 STFC programme awards and the group have been recommended

for a BBSRC supported ERA-CAPs collaborative grant. **Faulkner,** a new research fellow working on the consequences of fungal infection on intercellular transport, has just won a BBSRC New Investigator grant and works closely with **Hawes** on the role of reticulon proteins in organisation of plasmodesmata. Much of the group's work is carried out in collaboration with biophysicists at the STFC Lasers for Science Facility at the Rutherford Appleton Labs, Harwell using optical tweezers, 2 photon FLIM, optical trapping facilities and single molecule imaging.

Evolutionary Developmental Biology and Ecology:
McGregor and his group including **Santos-Nunes** are funded by an ERC Starting Investigator Grant, to study a number of questions central to understanding animal development and evolution: How has the genetic regulation of development evolved? What is the relationship between the genetic basis of morphological variation within species and that of differences observed between species? They address these questions from two different perspectives using flies of *the Drosophila melanogaster* species subgroup, and the spider *Parasteatoda tepidariorum.* Important results include the discovery that Wnt8 regulates posterior development in spiders, which suggests this pathway, in combination with Delta-Notch signalling, was involved in posterior development ancestrally in arthropods and perhaps other animals. *otd*, *hb* and *dll* regulate segmentation in spiders and this provided evidence that *hb* and *dll* act as gap genes in these chelicerates. Multiple mutations in enhancer sequences of the gene shaven-baby underlie the evolution of larval trichomes in *Drosophila*. They have also mapped the genetic basis of variation in eye size within and between *Drosophila* species and discovered that the evolution of a microRNA underlies morphological variation in *Drosophila*. With **Breuker** the group runs a biennial Eco-Evo-Devo international research summer school.
Breuker works on the Speckled wood butterfly, *Pararge aegeria,* as a model organism and investigates its reproductive success under a range of environmental conditions. In order to understand reproductive variation he investigates the developmental genetic regulation of oogenesis and quantifies variation in key regulatory genes among populations. Furthermore, he studies the evolution of those regulatory mechanisms that appear unique to butterflies. Such studies are crucial in elucidating, for example, life-history trade-offs, maternal regulation of embryogenesis, and oocyte pathology. The group was the first to report a butterfly ovarian transcriptome (including the identification of all the maternal transcripts present in mature oocytes), and identify the unique regulatory aspects of butterfly oogenesis. They described the spatio-temporal maternal gene expression patterns in butterfly ovaries and embryos and characterised in detail the genes implicated in hormonal control of oogenesis and transgenerational hormonal effects in butterflies.
Shreeve works within the **CEEC** (see below) on the understanding of the interactions of organisms with complex and heterogeneous environments. To meet national and international biodiversity targets, it is critical to know how species and communities responded to past changes and how they will respond to future landscape scale changes of resource distributions and changes of climate. He primarily works on butterflies, which are an indicator taxon of environmental quality and change. This work focuses on defining the precise resource requirements of species. Current work is focused on determining the thermal requirements of butterfly species and modeling their responses, in terms of activity and microhabitat use, to the thermal environment. This helps address the question of how species and species assemblages respond to the physical structure of habitats because microclimate is influenced by physical structure. Work is also being conducted on how the spatial availability and distribution patterns of resources influences the permeability of landscapes for individual species and thus their responses to environmental change. He is supported by **Dapporto** a research fellow who works on molecular biogeography and modelling.

Cell & Molecular Biology:
The Molecular Neuroscience group run by **Bermudez** with **Mazzeferro** studies the functional relationships of ligand-gated ion channels, with emphasis on the functional architecture of brain nicotinic acetylcholine receptors (nAChR). These ion channels are implicated in a wide range of diseases of the human brain, including Alzheimer's and Parkinson's. Tourette syndrome, schizophrenia, autism, drug addiction and attention deficit disorders. The techniques of molecular biology, radioligand-binding assays and two-electrode voltage-clamp recordings are combined to provide a multidisciplinary approach to the topic. They have shown that the function of diverse

nAChR subtypes can be influenced by many types of chemical compounds, ranging from cytisine to dihydropyridines, and by auto-antibodies in a receptor subtype selective manner, which may aid the development of safer therapeutic nicotinic drugs. Using fully concatenated a4b2 nicotinic receptors, in combination with single point mutants in the agonist binding region, and the substitution cysteine accessibility method, an additional operational agonist site was identified that confers receptor- specific functional signatures. The discovery adds a new complexity to the mechanisms that generate overall signals in nicotinic receptors.

Within this group **Jones** works on the gene diversity and the resulting functional/ pharmacological properties of ligand-gated ion channels. He is focusing on cys-loop ligand-gated ion channels of invertebrates that play key roles in signalling throughout the nervous system and are potential targets for pesticides and drugs used to treat parasitic worms. The aim elucidate mechanisms leading to pesticide and drug resistance, to provide a basis for developing pesticides that act selectively on pest species. Work on genome sequencing projects, has revealed how cys-loop ligand-gated ion channels diversify in insect species, ranging from crop pests to beneficial insects. He has shown how alternative splicing can produce an alpha and beta form of the nicotinic acetylcholine receptor, providing insights into the mechanism of evolution of this group of receptors. Also, for the first time in a cys-loop ligand-gated ion channel, alternative splicing and RNA editing have been shown to act in concert to alter properties of the receptor, fine tuning its sensitivity to a neurotransmitter. Group funding has been from industry and the Leverhulme Trust.

King's Insect Virus Group undertakes both basic and applied research in the field of insect virology. Projects focus on the replication and pathogenesis of baculoviruses both in cultured insect cells and in the natural caterpillar host. They work on the interrelated roles of three virus proteins, cathepsin, chitinase and P10, and the interactions between virus proteins and the host cell cytoskeleton and endomembrane system. Current projects include the role of virus P10, cathepsin and chitinase proteins in mediating cell lysis and virus transmission and have shown that phosphorylation of P10 is key to its structure and function. The results of these studies have helped them develop a greatly improved baculovirus expression vector. They also study the development of baculovirus vectors for gene expression in mammalian kidney cells to ameliorate the effects of ischaemia reperfusion injury following transplantation. Work on the the interactions between baculovirus and insect cells utilising fluorescent protein tagged virus proteins and a range of organelle markers for live cell imaging to uncover how the host cell changes during viral infection is carried out in collaboration with biophysicists at the STFC the Rutherford Appleton labs, Harwell using two photon FLIM and optical trapping facilities. Other funding has been from the BBSRC and Industry. With the spin out company Oxford Expression Technologies (King is a founding director), they are engaged in the exploitation of baculoviruses as expression vectors for protein production for use in biotechnology, medicine and as vaccines with an aim to use the understanding of the replication and pathogenesis of the virus to make significant improvements to the expression system.

Vaughan's Trypanosome Group with **Hughes** works on the cell biology of the African sleeping sickness parasite *Trypanosoma brucei,* which causes sleeping sickness in humans and Nagana in sub-Saharan African cattle. They study cell morphogenesis and the three dimensional organisation of the cytoskeleton and organelles to understand the role this configuration plays in cell duplication, inheritance of organelles and shape changes during cell division. Current work focusses on the flagellum, which, besides motility, is required for cell morphogenesis and is a major factor in the pathogenicity of the parasite. These questions are addressed using both molecular and 3-D tomographic imaging approaches. With the new technique of serial block face scanning electron microscopy, they have produced 3-D reconstructions of whole cells and have also discovered a new attachment structure at the distal end of the growing flagellum present only in the mammalian bloodstream form of the parasite. Future work will seek to discover novel genes involved with this highly unusual structure. Work is supported by BBSRC new investigator and travel grants.

Bolanos-Garcia studies spindle assembly at the mitotic checkpoint (SAC), the evolutionarily conserved and self-monitoring surveillance system that is indispensable for the segregation of chromosomes during cell division. Understanding of the function and mode of regulation of the SAC requires definition of the structural details of the individual subunits and different

subcomplexes. He has used X-ray protein crystallography, NMR, small-angle X-ray scattering, surface plasmon resonance, analytical ultracentrifugation, isothermal calorimetry and the yeast-two hybrid system. Key results include: the definition of the 3D structure and function of the conserved region of Bub1, BubR1 and Mps1, a group of multidomain protein kinases that play key roles in the mitotic checkpoint; the Identification of CENP-C as the pivotal molecule that links centromeric DNA to the kinetochore, and the crystal structure of BubR1 in complex with the central kinetochore component KNL1/Spc105. The latter structure has provided the first molecular insights into the communication between the mitotic checkpoint and the kinetochore, and revealed an unanticipated mode of ligand binding in BubR1 and a novel protein binding motif in KNL1/Spc105.

Biomedical Science:
Kadhim runs the **Genomic Instability Group** funded by the EU, US Dept. of Energy and NASA working on 'non-targeted effects' of ionizing radiation. These include Genomic Instability (GI), a hallmark of tumorigenic progression induced by radiation, cell communication and Bystander Effects (BE) using mammalian and human haemopoietic stem cells and a variety of other human cell lines. Several key molecular approaches such as cytogenetics, telomere analysis and immunofluorescence are used. Research aims to understand how GI is initiated and perpetuated in both directly irradiated and bystander populations, including signalling pathways linking these populations, and how non-targeted effects of radiation are influenced by genetic variability, radiation type and doses. They demonstrated intra-individual variation in GI induction under bystander conditions, a discovery with implications for environmental dosimetry and radiotherapy. Other key findings include involvement of genetic factors (*in vivo/in vitro*) in the mechanism of non-targeted effects using mammalian haemopoietic systems; identification of communication molecules e.g. TNF-α and TGF-β associated with GI, and exosome association with GI and BE.

Meredith's Membrane Transport Group, funded by Wellcome Trust, CRUK, MRC and Astra Zeneca, works on the structure-functional relationship of membrane transport proteins, especially those involved in the uptake and delivery of nutrients across cell membranes of intestinal enterocytes and renal proximal tubule absorptive epithelial cells, as these are potential routes for drug delivery and absorption. Work concentrates on four types of transporter: the proton-coupled di- and tri-peptide transporters (PepTs), the proton-coupled amino acid transporters (PATs), human PAT1 and PAT2, and the organic anion transporting polypeptides (OATPs). Major findings include: identifying the function of orphan transporters, including one identified by a genome-wide association screen/metabolomic profiling approach; advancing the molecular understanding of transport protein function; and investigating the transport of novel peptide-conjugated prodrugs by PepTs as potential routes of drug uptake and/or disease targeting.

Carter's Chromatin and Non-Coding RNA Group studies the cellular role of non-coding RNAs (ncRNA) including the regulation of gene expression and controlling chromatin structure. In the regulation of red blood cell development they are investigating how ncRNAs alter the structure of chromatin during red blood cell production. They have identified a long ncRNA that appears to play a role in regulating expression of the β-globin gene. A project on the role of non-coding RNAs in the regulation of cancer progression has identified several short ncRNAs (known as miRNAs) that contribute to the development of chemotherapy resistance in ovarian tumours. Carter's group has also performed a comprehensive meta-analysis of hundreds of publications to identify miRNAs that play roles in stress response. This information has been published as a database that is freely available to the scientific community. In a new project they have also discovered that small microvesicles carrying miRNAs mediate cell-cell communication following specific forms of stress. These findings have potential clinical applications in tumour progression and the response to chemo- and radio-therapy. The work is charity funded (Sparks, Cancer & Polio Research Fund, Dunhill Medical Trust, Action Medical Research and the Royal Society).

Forhead leads the **Perinatal Physiology Group** which works on the mechanisms responsible for fetal maturation, especially the role of hormones such as glucocorticoids, thyroid hormones and leptin. The group was BBSRC funded and has an integrative approach to examine the process of fetal maturation from the gene to systems level and combines investigations of whole animal physiology with stereological, biochemical and molecular biology techniques. Projects include: the

role of leptin in lung development before birth; examining pulmonary expression of leptin receptors in the fetal lungs and determining the effects of leptin treatment on pulmonary structure and function *in utero*; the effect of thyroid hormone deficiency on growth and maturation before birth, including development of the fetal skeletomuscular system, testis and pancreas, and the effects of natural and synthetic glucocorticoids on insulin signalling proteins in fetal skeletal muscle.

Ragge carries out charity-funded research on the molecular genetics of eye development. She has identified a new gene BMP4 for congenital eye defects associated with polydactyly, and brain anomalies. She identified FOXE3 as an important gene for both recessive and dominant eye anomalies, with different phenotypes for both - recessive mutations leading to aphasia, and dominant mutations leading to cataracts. A novel gene for anophthalmia, microphthalmia and brain anomalies - BMP7 - was discovered and she showed that it was also important in development of the ear and palate. She demonstrated preservation of architecture in the visual cortex and recruitment of other sensory modalities using functional imaging in individuals with anophthalmia. She published the first worldwide demonstration of oligogenic pathways contributing to eye development by identifying humans with TFAP2A mutations. She made a key contribution to the worldwide collaborative effort to identify and characterise novel candidate genes for anophthalmia and microphthalmia including identification of a new recessive anophthalmia gene in the retinoic acid pathway and further characterisation of another recessive gene in the retinoic acid pathway.

Primate Biology:
This group currently resides in the Dept. of Social Sciences. **Nekaris** (Leverhulme Trust funded) studies the ecology, taxonomy and conservation of, small Asian and African carnivores, monkeys, gibbons, lemurs, and galagos, focussing on the slow and slender lorises as a model for this group. Previously virtually unknown, Asia's slow lorises are declining rapidly due to wildlife trade for traditional medicines, photo props and pets. **Nekaris** examines how these practices differ from an ethnozoological perspective to help develop conservation policies across the region where lorises occur, has quantified all three types of trade, and has conducted the first ecological studies of several loris species. She discovered traits unusual amongst primates; paternal care, use of Batesian mimicry as an anti-predatory strategy, and an understanding of why slow lorises are the only known venomous primates. She has recently discovered three new species of slow lorises. Her field studies integrate conservation with education involving local people in initiatives to establish long-term conservation of the species. The slow loris has become one of the most popular endangered species via exploitation of illegal pets, and Nekaris' has addressed the impact of this phenomenon. All of her work feeds into Cites listings for loris genera, IUCN (International Union for Conservation of Nature) Red Listings, and an IUCN Action plan for slow lorises.

Nijman focuses on assessing the impact of human-induced disturbances (logging, fire, habitat fragmentation, farming) on vertebrates, with primates and birds as two of the model groups. This is studied at the individual level (how does disturbance affect the behaviour of individual animals?), local population level (comparing adjacent populations facing different levels of disturbance) and the landscape level (e.g. South-east Asia wide). He also assesses and quantifies the international trade in wildlife and aims at mitigating the impacts of this trade on wild populations and at better regulating the international trade. In addition to wild populations, he also focuses on animals in captive conditions, establishing for instance how captive-breeding facilities can aid in regulating the trade. Finally, he works on species concepts, phylogeny and systematics and how modern molecular techniques, including but not restricted to DNA barcoding, can aid in this quest. As with assessing the impact of human-induced disturbances, the focus is on birds and primates.

Donati has been conducting field research on behavioural ecology of Malagasy lemurs since 1996 with a focus on activity patterns and their ecological correlates. By comparing activity patterns of different species of lemurs and relating these to environmental variables, he elucidated some of the proximate and ultimate determinants of one of the least known primate adaptations, cathemerality (activity spread over the 24-hour cycle). These studies helped to gain a deeper understanding of the factors underlying the transition from nocturnality to diurnality during primate evolutionary history. He has also compared variations in food availability in Malagasy forests and explored the influence of food quality and distribution on lemurs' ecology. More recently he has expanded his interests toward more conservation oriented topics that also include anthropogenic pressure on endemic forests and the reconstruction of human arrival in Madagascar. Today

Donati's studies focus on behavioural response of lemurs to deliberate relocation and on their ability to cope with habitats at various levels of degradation. He was responsible for designing the 2013 IUCN Action Plan for the lemurs of South-eastern Madagascar.

d. Income, infrastructure and facilities

Over the past 5 years Biology research has been funded from an increasingly diverse range of sources including Research Councils (BBSRC, STFC, MRC, NERC, ERC), the Royal Society, European Commission (Framework projects, Marie-Curie ITN), various charities (Wellcome Trust, CRUK, Leverhulme Trust, Cancer & Polio Research Fund, SPARKS, Dunhill Medical Trust, Action Medical Research, VICTA & MACS [children's eye disease charities]) and NASA, plus the US Department of Energy. Biology researchers also have access to considerable funds from royalty income generated from IP on previous research (currently around £600K per annum, see Groome Impact Statement), which along with QR funding is reinvested in PhD students as the Groome studentship scheme. These funds also support early career research fellows, bridging grants, start-up grants, staff development and equipment.

Over the last 5 years there have been a number of major changes in the research profile of Biology staff due to retirements, alongside an increase in the number of research active staff as a result of a strategic recruitment policy. This has necessitated some reconfiguration of research laboratory space and due to this, during the REF period, the University has invested in upgrading several of the research facilities to support Biological research. In addition, two new tissue culture suites have been established, one licenced for pathogen work. Complete refurbishment of the virology and bioimaging laboratories has been undertaken. Funding has just been released for the conversion of an old lecture theatre to a new multi-purpose molecular biology research laboratory to house several of our expanding groups. The University has also invested in a new tomographic transmission electron microscope and scanning electron microscope plus ancillary equipment. These reside in the Bioimaging Unit which houses the confocal microscopes and is supported by RMC, an EM equipment company who donate, and frequently update, a cryo-ultramicrotome, a freeze-substitution apparatus and minor items of equipment to the Unit with an in-kind value of around £150,000. **Hawes** and **Vaughan** have just been awarded £750K by the BBSRC to establish a regional high resolution SEM facility within the unit. The **Centre for Ecology, Environment and Conservation** was established in early 2012, with the remit of providing a focus for research, consultancy, teaching and training in ecology, environment and conservation. It hosts all the ecological research in the Department.

e. Collaboration and contribution to the discipline or research base

All researchers are encouraged to contribute as fully as possible to support their individual disciplines through various external activities, editorships and committee membership. Most have long established national and international collaborations. For example:

Hawes: Holds editorial positions for J. Microscopy, Traffic, J. Integrative Plant Biology and J. Experimental Botany. He is Hon Secretary of the Royal Microscopical Society and served on a BBSRC grants panel. He currently sits on the STFC Central Laser Facility Board and Large Scale Facilities Sub-Group and is a Fellow of the Society for Biology (FSB). He is a Board Member of the Oxfordshire Bioscience Network. He has significant collaborations with plant scientists in Warwick, Edinburgh, Wageningen, Michigan State and Syngenta. He runs a consortium of plant cell biologists from Brookes, Warwick, Reading, Exeter and Vienna which has established an interdisciplinary collaboration with researchers at the Central Laser Facility STFC, Rutherford Appleton Labs. via an STFC Programme Access Grant.

Runions: is Cell and Molecular Biology Editor of Annals of Botany Plants, and Associate Editor Frontiers in Plant Traffic and Transport. He runs the annual RMS Cell Imaging course and is a member of the RMS Life Sciences Committee. He collaborates with several European labs and Southampton (joint BBSRC grant) on membrane protein dynamics and is COI on a newly awarded BBSRC equipment grant for a STED microscope with collaborators at the LSF at Harwell.

Graumann: Holds a Leverhulme Trust Early Career Fellowship and won an EMBO Short Term Fellowship. She has established international collaborations with Blaise Pascal University, Ohio State University plus working with nucleus researchers at Birmingham, Cardiff and Exeter. She is a founder member of the International Plant Nucleus Consortium.

Osterrieder: Was awarded the SEB President's Medal for Education and Public Affairs in 2012. As a result of her outstanding science outreach activities she was invited to the 2013 Woman of the Year lunch. She collaborates with researchers at Wageningen, Reading, Vienna and the STFC

labs. Harwell and works with researchers at Syngenta, Jealotts Hill.
Faulkner: Collaborates with plant pathologists at the Universities of Turin, Goettingen and Edinburgh plus the Sainsbury labs. at Norwich.
Fell: A FSB, was invited to be a member of a party of UK scientists who visited New Delhi and Mumbai in India in October 2011 for a workshop with a group of Indian researchers to explore potential for establishing joint bioenergy research projects funded by the BBSRC and India's Department of Biotechnology. This resulted in two BBSRC India Partnering Awards. He has been Chair of the Biochemical Society's Policy Committee from January 2012 and is a Council member and Trustee of the Biochemical Society. In 2012 he was appointed a member of the BBSRC's Industrial Biotechnology and Bioenergy Strategy Advisory Panel. **Fell** and **Poolman** ran a Harden conference on Metabolic Pathway Analysis in 2011 and were coorganisers of the meeting in 2013.
Bermudez: is associate editor of Frontiers in Membrane Physiology and Biophysics and has collaborations with the Barrow Neurological Inst. Arizona and Dept. Chemistry, University of Chile.
Mazzaferro: has established collaborations with the University of Chile and Salerno, Italy.
Jones: has participated in four major international insect genome projects and is Technical Reports Editor for Invertebrate Neuroscience.
King: A FSB, has completed a term of office as Insect Virus Editor for J Gen Virology. She has sat on the BBSRC Institutes' Strategic Funding Review Panel, was a member of the Visiting Group for IAH Compton, is a member of the L'Oreal Awards Panel for women in science; she leads the University strategy for Athena Swan and sits on the Oxford University Biomedical Research Centre Steering Group. She has established a number of collaborations including STFC (Harwell), BBSRC Pirbright Laboratory, NERC CEH (Wallingford), Oxford University and the University of Wageningen. She also works closely with industry via Oxford Expression Technologies Ltd, including major pharmaceutical companies, biotechs and ProteoNics in the Netherlands
McGregor: is an Editor for PLoS ONE and Journal of Evolutionary Biology. He is a FSB, a member of the European Society for Evolutionary Developmental Biology and the ATIP/CNRS Grant Review Panel.
Carter: was editor of Scientific World Journal 2009/12 and collaborates with researchers at Universities of Saskatchewan, Imperial College and the Babraham Institute.
Breuker: is an editor for PLoS ONE and a member of a large scale butterfly sequencing project with Stockholm, Reading, Oxford University and the Catholique University of Louvain.
Shreeve: is Editor in Chief of Journal of Insect Conservation and a member of the Linnaean Society Taxonomy & Systematics Committee (education, training and careers group).
Hughes: Collaborates with RMC (Boeckeler Inst.) on the applications of high-pressure freezing and freeze substitution in electron microscopy.
Kadhim: is a member of Committee on Medical Aspects of Radiation in the Environment (COMARE), a member of COMARE Medical Practices Subcommittee (Computed Tomography (CT) and a UNISON-Iraq Office committee on higher education across Iraq. She has a number of international collaborations including the EU Low Dose DoReMi programme, funding to work for NASA and the US Department of Energy on low dose radiation, plus a joint programme with the Karolinska Institute in Sweden. In 2012 she organised and hosted a major workshop on Systems Radiation Biology.
Bolanos-Garcia: collaborates with researchers at the Universities of Cambridge, Copenhagen, Rennes and Laval (Canada).
Forhead: is a member of the editorial board of ISRN Developmental Biology and has collaborations with researchers at the Erasmus Medical Centre, Rotterdam, University of Western Australia and Washington State plus various UK universities.
Ragge: Held an Academy of Medical Sciences Senior Clinical Fellowship (2008-09), is Associate Editor of the Journal of Medical Genetics and has collaborations in Tolouse, Paris and Baltimore.
Nekaris: is an editor of Folia Primatologica, Taprobanica /Indonesian Journal of Biodiversity and the Journal of Threatened Taxa. She is a member of the IUCN Primate Specialist Group and recipient of the 2012 Lawrence Jacobsen Conservation Research Award.
Nijman: edits contributions to Zoology and Taprobanica, is a member of the CITES Scientific Authority of the Netherlands and a member of the IUCN Primate Specialist Group.
Donati: is a member of the IUCN Primate Specialist Group.