Institution: University of Bristol

Unit of Assessment: UoA6 – Agriculture, Veterinary and Food Science

a. Overview

This submission is based primarily on research outputs of members of the School of Veterinary Sciences (SVS) who are concerned with the teaching and clinical service associated with training students for the RCVS-recognised BVSc degree. Their teaching responsibilities also include a small cohort of students (~110 FTEs) on the Veterinary Nursing and BioVeterinary Sciences and Animal Welfare and Behaviour BSc programmes. Members of the School of Biological Sciences involved in veterinary research and teaching are also included. SVS is part of the Faculty of Medical and Veterinary Sciences (FMVS) which provides a highly collegiate and collaborative research environment. Collaborations with the Faculty of Medicine and Dentistry (FMD) also provide an increasingly important contribution to the School's research profile. Staff teaching veterinary students Biochemistry, Physiology and Pharmacology are returned in other UoAs.

The School has gone through a period of innovative change in recent years which has included redefining its vision and research strategy, significant investment in new facilities and the appointment of new staff working in areas of strategic importance. A major change has been the establishment in 2009 of Langford Veterinary Services (LVS) to manage its veterinary clinics. This wholly owned subsidiary company is a unique business model amongst UK veterinary schools and by significantly increasing the caseload is providing more material for clinical and comparative research.

The overall strategy is to direct research towards the linked goals of optimal health for animals, people and the environment – so-called **'One Health'**, and veterinary research plays a vital role in the research agendas of two new institutes established by the University since the previous submission; the cross-faculty **Elizabeth Blackwell Institute (EBI) for Health Research** and **Cabot Institute for Environmental Research.** The **EBI** was established in 2012 to identify and nurture new opportunities for interdisciplinary research by exploiting expertise in the non-medical faculties, and translating that research into effective health outcomes, including animal health. The **EBI** also identifies and supports the best young clinical talent through a series of fellowship schemes, and creates an environment for effective collaboration with external partners within and outside Bristol. **The Cabot Institute** carries out fundamental and responsive research on risks and uncertainty in a changing environment and **Global Food Security** is a major focus of its research.

Veterinary research activity is organised through three strategically important groupings: **Animal Welfare and Behaviour** (AWB), **Infection and Immunity** (I&I) and **Comparative and Clinical Research** (C&CR). **Translational Research** is a major focus of the I&I and C&CR groupings and is directed to using natural disease and experimental intervention in animals to increase understanding of human and animal disease and inform the development of new therapeutic interventions for humans and animals.

Collaboration between individuals in the main research groupings is facilitated by the School's cross-disciplinary research themes. The **Biostatistics, Epidemiology, Mathematics and Ecology** (BEME) theme brings together those whose research can benefit from sophisticated statistical and mathematical approaches. The **Global Food Security** theme is a forum for the development of ideas and collaborations in the area of sustainable agriculture, embedded within the Cabot Institute. To support this theme, a **Food Security and Land Research Alliance** (FSLRA) has been established between the Rothamsted Research Institute and the Universities of Bristol, Bath, Cardiff and Exeter and through a new appointment (Lee) the vet school is playing a key role in shaping the Alliance's future. The **Translational Research** theme brings together those in C&CR who work with naturally occurring diseases in the caseload and other researchers in the wider University who are developing preclinical, translational models. The development at Langford of a preclinical research centre (due to open in 2015), which incorporates a 3Tesla MRI, offers enormous potential for developing translational research using a variety of experimental models in areas of existing research strength at Bristol, and in cardiovascular biology and neuroscience in particular.

b. Research strategy

The School's strategy is directed to being world leading in its ability to translate fundamental research into improved health and welfare of animals and humans and to increase sustainability of livestock production within "welfare friendly" limits. This strategy involves creating an excitement for research in those with relevant interests, building on existing research strengths and developing new ones, identifying and supporting new collaborations, utilising emerging technologies, upgrading existing facilities and building new ones, and making strategic academic appointments.

The key objectives are:

- To promote the **'One Health'** agenda.
- To develop **Global Food Security** and **Translational Research** as major research themes**.**
- To use the BEME **to maximise the use of quantitative analysis** within each group.
- To promote and support internal and external within- and cross- disciplinary collaborations making full use of the University's significant investment in developing technologies.
- To develop the ethos and material environment within the School and the Langford campus to provide a centre of excellence in basic, clinical and translational research, sufficient to attract and retain world class staff.

To facilitate this strategy, staff are formed into groups specifically directed to supporting existing research strengths and promoting novel areas of research through external collaboration. These thematic groups are neither 'silos' nor administrative units, but functional groupings of staff with cognate interests. Many staff belong to more than one group and are strongly encouraged to collaborate internally and externally. All of the research groupings benefit greatly from being part of a research intensive university and are formally involved in cross-faculty research initiatives; e.g. the Regenerative Medicine Strategy Group.

Research group leaders have both external and internal roles. Externally they raise the profile of their disciplines by working with potential funders and help to attract research fellows, postdoctoral researchers, PhD students, visitors, collaborators etc. Internally they promote the research ethos within the disciplines in their research grouping by organising and managing activities (seminars, away days etc), supporting grant applications, gathering, communicating and publicising research activities and mentoring colleagues. They also play a critical role in fostering inter-school and inter-disciplinary initiatives and contribute to Staff Review and Development (SR&D).

Animal Welfare and Behaviour

This world-renowned group has, since RAE 2008, been strengthened by new key appointments and increased external funding. A major achievement has been to secure University funding for a £3M new building in which epidemiology and farm animal science colleagues are co-located, creating a vibrant and inter-disciplinary research atmosphere with a focus on sustainable food production (http://www.bristol.ac.uk/biology/research/behaviour/centre/).

Research in AWB spans fundamental studies of cognition and emotion, through validation of animal welfare assessment methodologies, identifying and quantifying welfare problems and their causes in farm, laboratory, companion and working animals, to implementing research based solutions in the 'real world'. This unique integrated approach is achieved by collaboration between senior PIs with expertise in different areas including; fundamental behaviour, cognition, emotion (Held, Mendl, Nicol); companion animal behaviour (Casey); welfare on farm and implementation of welfare solutions (Knowles, Main); and statistical and mathematical approaches (Browne, Rands). The group collaborates extensively outwith SVS, and AWB research is firmly embedded within the University Research Centre for Behavioural Biology (an interdisciplinary venture between Biological Sciences, Mathematics and Veterinary Sciences).

Major achievements include:

- A new functional framework for the objective study of animal emotion, with development and implementation of associated novel indicators of emotion and welfare.
- The first demonstration of foundational empathic capacity in birds.
- Establishing the quantitative relationship between the two main animal welfare assessment

methodologies (welfare indicators and animal preference), including the first ever validation of welfare indicators against animal choice.
- Quantifying the risk factors underlying important welfare problems like feather-pecking and keel-bone fractures in chickens in a commercial context
- Effective implementation of scientific findings via legislation, assured standards, and knowledge transfer to improve animal welfare in the UK, Europe and developing countries.
- Development of statistical software for Bayesian analysis of epidemiological data which has had a major impact on research in many disciplines around the world.
- Mathematically modelling social interactions to provide a theoretical framework on which to build an understanding of dyadic and group social behaviour.
- Compelling evidence that birds are capable of experiencing pain and the demonstration that slaughter by ventral neck incision (shechita "ritual" slaughter) is noxious to cattle and that this can be ameliorated by prior stunning.
- Major external awards: The Humane Slaughter Association 'John Ace-Hopkins Award for Significant Advances in Humane Slaughter' (Knowles and colleagues); the Universities Federation for Animal Welfare Medal for 'Outstanding Contributions to Animal Welfare Science' (Nicol) and the International Society for Applied Ethology's Inaugural Creativity Award (Mendl and Paul for their work on cognitive bias).

Infection and Immunity

This grouping brings together a number of research strengths, ranging from the fundamental to more applied research with potential for impact. All collectively benefit from being part of a University-wide research theme (http://www.bristol.ac.uk/infection-immunity/). The research areas contributing to this synergy include; immunology (Stokes, Bailey, Harley, Wooldridge, a recent appointment), microbiology (Wilson and Cogan, a recent appointment), mathematical modeling (Turner, a recent appointment), companion animal infectious diseases (Tasker, Harley) and veterinary parasitology (Gibson, Wall and Morgan, who has recently moved to SVS from Biological Sciences).

Because ***increased sustainability of livestock production within "welfare friendly" limits*** is central to the School's strategy, we have considerably strengthened infection and immunity research during the course of the assessment period by the appointment of staff with expertise in endemic farm animal diseases (Eisler, Palgrave, Lee, Reyher and Uehlinger).

During the review period research has attracted over £5.7m of support from the BBSRC, EU-FP7, Defra, MRC, NIH, Wellcome Trust and industry (Nestlé, Novartis, Pfizer).

Major achievements include:

- As highlighted in our previous strategy (RAE 2008), the immunology group has continued to develop a programme of translational research using the pig as a large animal model of human disease. Successful, pig laryngeal transplants have been followed by the first clinical transplantation of tissue engineered bronchi to an adult human.
- Demonstration that rearing environment profoundly affects the development of the mucosal immune system and susceptibility to allergic disease in young pigs. Establishing the importance of "cross-talk" between intestinal microbiota and host innate and adaptive immunity, so providing a rational scientific basis for the development of probiotics.
- Demonstrating that the pathogenicity of the causative agent of foot rot in sheep is modulated by the skin microbiome, and that antibiotics are the most effective therapeutic option.
- The use of epidemiological modelling tools to identify the mechanisms whereby parasitic diseases of sheep adapt to climate change.
- Identification of new genotypes of the cattle pathogen *Trypanosoma vivax*, and publication of the genome sequence of the human pathogen *Trypanosoma brucei gambiense*.
- Demonstrating the meiotic stages of the life cycle of *T. brucei* in the salivary gland of the tsetse fly which contribute to the appearance of novel strains by recombination. Identifying the wild animal host range of tsetse-transmitted trypanosomes including human infective *T. brucei rhodesiense* in the Luanga valley.
- Validating a decision support tool for diagnosis of endemic, vector-borne and parasitic bovine

disease in developing countries.
- First discovery of a novel haemoplasma species associated with clinical disease in humans.
- Appointment of Wooldridge to a chair to lead a programme in Translational Immunology. Her lab is based in the Medical Sciences building in order to facilitate collaborative links with immunologists and microbiologists in the School of Cellular and Molecular Medicine. Wooldridge has recently demonstrated that T-cell receptor specificity is highly promiscuous, opening the way for novel therapeutic approaches.
- Appointment of Turner, an infectious disease modeller currently supported by an NIHR Fellowship, to a senior lectureship in Infectious Disease Epidemiology. This will develop further links with colleagues in the FMD working on infectious disease epidemiology. Turner has recently combined complex and individual-based mathematical models to identify optimal use of resources to control chlamydia infections, an approach taken up by HIV groups.
- Award of £500K from BBRSC and Rothamsted Research (RR) as a "start-up" package for Lee to develop a multi-disciplinary research programme in food security and sustainability based around the North Wyke Farm Platform.

Comparative and Clinical Research

This grouping specifically recognises the importance of research on naturally-occurring diseases within the clinical caseload directed towards the prevention and treatment of animal and human diseases ('One Health'). The group includes veterinary clinical specialists engaged in high quality clinical research, biomedical scientists who study fundamental physiological mechanisms and disease processes (e.g. ageing), both of whom may work on small and large animal pre-clinical models of disease. Major investment in new clinical and imaging facilities (~£10M) reflects a commitment to supporting and developing the group's activities, and the establishment of LVS has transformed clinical service provision meaning that the case material available for case-based research has increased.

Key strategic objectives in recent years have been to build a critical mass of clinical specialists in cardiology and neuroscience, areas of existing translational research strength in Bristol, and to more effectively support collaborations between clinician scientists and basic scientists. The **One Health Initiative** and **Translational Research** have now become fully integrated within the University's cross-faculty EBI for Health Research which also provides funding for 'research tasters' for clinicians to carry out research in basic biomedical laboratories. The School has also been successful in securing Fellowship funding from the Wellcome Trust's Clinical Veterinary Research Training Initiative (CVRT) as part of its commitment to supporting the career development of veterinary researchers.

Major achievements include:

- Recruitment of Granger will ensure that the Vet School is fully engaged in the university wide initiative on Regenerative Medicine. He contributed to ground breaking translational research showing that functional recovery can be achieved following the use of autologous stem cells for the repair of naturally-occurring spinal lesions in dogs. This research could have enormous benefit for human and animals.
- The recent appointment to a new chair in Companion Animal Orthopaedics (Langley-Hobbs) will facilitate case-based research and the translation of musculoskeletal regeneration research (e.g. the use of stem cells in tendon repair).
- Successful application of SNP analysis to determine the immunopathogenesis of a common debilitating condition in a companion animal species (canine anal furunculosis).
- Identification of potential targets in midge saliva responsible for equine allergic reactions in 'sweet itch', opening the way for future desensitisation protocols.
- Validation of a new translatable pain model in rats.
- Use of animal models, in parallel with studies in human patients, to demonstrate a key role for galanin in demyelination.
- Demonstration of an association between chondrocyte apoptosis and osteoarthritis (OA).
- Dietary omega-3 polyunsaturated fatty acids influence the severity of naturally occurring OA and reduce the prevalence of keel bone fractures in hens.
- Applying the results of extensive rodent studies to determine that point mutations in human

TRAP cause bone dysplasia and autoimmunity.
- Demonstration that bone's response to mechanical strain is context dependent and that, rather than there being a single linear pathway between mechanical strain and bone formation, multiple pathways are involved. Oestrogen receptor alpha (ERα), acting genomically and non-genomically, plays a critical role in the regulation of bone mass, subsequently confirmed by human GWAS studies. For this, and previous work, Lanyon was presented with the William Neuman Award, the most prestigious award of the American Society for Bone and Mineral Research (ASBMR) which recognizes outstanding scientific contributions in the area of bone and mineral research.
- In 2008 Tasker was presented with the British Small Animal Veterinary Association's (BSAVA) Woodrow Award, an international award for outstanding contributions in small animal veterinary medicine, and in 2013, the Petplan Charitable Trust Research Award.

Research over the next 5 years

The research strategy involves: (i) Building on existing re*search* strengths *(developing new methods of assessing animal pain and welfare*), (ii) Developing new research strengths (*improved mathematical models to study spread of veterinary infectious diseases*), (iii) Identifying and supporting new collaborations (*FSLRA*), (iv) Utilising emerging technologies (*metabolomics to develop novel veterinary disease biomarkers*), (v) upgrading existing facilities and building new ones (*pre-clinical translational research centre at Langford, Biological Sciences building*) and (vi) making further strategic academic appointments (*Wooldridge, Eisler etc*).

This School's strategy has already delivered the award of a number of major new collaborative grants in 2012/13, demonstrating that it is delivering the desired outcomes. This funding (> £8M, not all captured in REF4b), will ensure that research productivity continues on an upward trajectory. Building on previous ground-breaking work, AWB researchers will develop and validate new methods of assessing animal pain and welfare in dogs and hens (funded by new BBSRC grants). BBSRC and NC3Rs funding will further develop fundamental work on cognitive bias, animal emotion and welfare, in collaboration with computational neuroscientists at UCL. Members of the I&I group will continue to translate fundamental science to the field through two TSB-funded projects; development of an automated pen-side faecal egg counting system for livestock and improving mineral bioavailability in silage. Lee has secured significant funding from RR to establish livestock-related sustainable agriculture research at the North Wyke platform. Members of the group will also participate in a new BBSRC-funded LoLa, led by IAH Pirbright, to study the transmission of influenza virus in pigs. Exciting opportunities are opened up by the MRC funding for new imaging platforms to support regenerative medicine research.

We will build on these successes with major funding applications including; (i) the use of stem cells for repair of neurological lesions using the dog as a target and a model, (ii) dissecting the role of antigen-specific T-cells in chronic diseases such as cancer, autoimmunity, TB and HIV and using this information to inform novel therapeutic approaches, (iii) using life-course studies of UK cattle to establish genetic associations with susceptibility and co-susceptibility to endemic diseases, (iv) establishing the role of epigenetics in the adaptive remodelling in bone and in ageing, (v) using new mathematical models to study the spread of infectious diseases which include both the evolution of bacterial genomes and transmission dynamics.

Mechanisms and structures for promoting research

Research continues to be led by a Head of Research, a member of the School's Senior Management Group (SMG), who works closely with the Head of School. The Head of Research chairs the Research Committee whose membership includes leaders of research groups, the Head of School and theme leaders. The Committee sets strategy, oversees structures put in place to manage research and promote a research ethos, disseminates information about funding initiatives, co-ordinates collaborative bids, communicates and implements University policies. The Head of Research also sits on the Faculty Research Committee and is thereby facilitates communication between the School, the Faculty and wider University.

In recent years the Research Committee has overseen a number of new processes established to enhance the research ethos and material environment. These include; (i) a compulsory grant reviewing process, (ii) grant writing workshops, (iii) a research mentoring system, (iv) fortnightly

research lunch meetings that provide an opportunity for all members of the School to hear about ongoing research through two short, accessible talks by staff or graduate students, (v) a weekly single-site seminar series (previously seminars were organised by divisions) at which internal and external researchers and final-year PhD students present their work. A Research Support Officer was appointed in 2010 whose role is to coordinate the above activities, to work with Finance to provide the SVS Management Committee with information relating to grants, and to provide researchers with general advice (e.g. on research facilities available at Langford and in Bristol). A new technical staff structure put in place in 2012 ensures that support is available to a wide constituency of academics.

In order to further support clinical, case-based research, a number of specific strategies have been implemented since 2009; (i) the recent appointment of a new clinical chair in orthopaedics (ii) creation of a clinical research nurse position, (ii) ensuring LVS is in a position to directly support clinical research through a formal financial agreement and indirectly by continuing to increase the caseload, (iv) a system has been established whereby clinical academics can apply for research grants from The Langford Trust for Animal Health & Welfare, a University-affiliated charity, (v) regular evening research soirée sessions with a focus on clinical research have been successful at engaging clinicians and providing them with an opportunity to meet other research-active staff.

c. People. Staffing strategy and staff development

In common with other Veterinary Schools, recruitment strategy is strongly influenced by the requirement of a significant proportion of staff to have the appropriate clinical qualifications to teach veterinary students. LVS require all staff working in its referral clinics to be specialists. When it was established in 2009 a number of clinical posts were transferred to LVS, which is one of the reasons why the number of FTEs returned in this submission is lower than 2008.

Working within this contextual framework, we have made a number of appointments targeted to areas of existing or developing research strength since the last submission. This has been facilitated by retirements of a number of senior academics, particularly those working in the areas of meat science, meat quality and food safety who were originally part of the Meat Research Institute.

Because Bristol's vision is to become a leader in production animal health and welfare research, Eisler has been appointed to a new chair in Global Farm Animal Health, and to acquire much needed expertise in Sustainable Agriculture and to exploit the North Wyke Farm Platform, Lee was appointed to a readership position in 2013. New clinical appointments in Farm Animal Science bring additional expertise in production animal endemic disease epidemiology. The recent appointment of Turner builds strength in disease modelling, as does the transfer of Morgan from Biological Sciences. The appointment of Price as Head of School and of Lanyon has re-established bone mechanobiology research at Bristol. Cogan was appointed to a lectureship in 2013 to ensure expertise is maintained in applied microbiology. Wooldridge has been appointed to ensure that Bristol continues to be recognised as a leader in translational immunology. Four of these posts replace teaching only roles.

The recruitment policy for new clinical appointments is in line with our overall strategy. All new appointments are made within areas where there is existing critical mass in SVS, but also, importantly, in areas that enhance links to the areas of translational research strength in the wider University. Two specialist clinicians with PhDs are developing links with the Bristol Heart Institute (Chanoit and Fonfara). Another area of strategic focus is neuroscience/neurology and to develop translational research programmes in neural regeneration we have recently recruited an academic clinical neurologist (Granger). Where such coincidence between clinical requirement, research fit and quality/qualification of applicants has been impossible to achieve, we have appointed staff whose time is dedicated 70-100% to clinical activities (including case-based research) onto the University's new teaching-only career pathway (Pathway 3). This allows greater flexibility and enables research-trained clinicians to have sufficient time and 'space' to develop independent research programmes.

Staff Development: New appointees have more experienced staff as research mentors and are provided with ring-fenced start up research funds, a reduced teaching and clinical load and preferential consideration for postgraduate studentship applications. All new, core-funded staff

have long-term objective setting meetings with the Head of School, followed up with compulsory annual Staff Review and Development (SR&D) meetings. To ensure that we meet the requirements of the Concordat to Support the Career Development of Researchers, it is now a requirement that all Pathway 2 staff (the majority of whom are externally funded) have annual SR&D meetings.

The University offers a series of courses to help new lecturers and more junior research staff establish their careers (e.g. Research Enterprise & Development plays an active role in running grant writing workshops). Senior staff are also encouraged to attend courses on managing and leading research groups. Academics with experience of successfully applying for grants from different funding bodies (e.g. research council, medical charity, EU, government) provide a pool of specialist mentors that staff consult before submitting a grant application. Internal workshops help staff prepare grants and a part-time post (Lanyon) facilitates this process. In order to improve the quality of grant applications all applications are required to be submitted for critical and constructive review well before the funder deadline.

Research students: The Graduate School of FMVS provides a supportive and stimulating environment for postgraduate research students. The Graduate School is responsible for every aspect of postgraduate study from application, registration and annual progress monitoring, through to completion of studies. It provides a programme of transferable-skills training, recognised by the UK's leading research councils, to complement every student's study. This training programme includes over 30 courses each year and helps students to develop and improve their expertise in areas including; public speaking at scientific conferences; creating and delivering presentations; writing academic papers; the ethical implications of biomedical research; career management etc.

There is an annual review process which, in addition to the training needs identified by the supervisory team and student, is an opportunity for two academic members of staff who are not directly involved in the student's work to assess the student's skills and, if necessary, recommend that they be improved by attending one or more of the Faculty's skills training courses. All students are issued with a Research Student Log Book at the start of their studies. Pages have to be completed by the student at 1-week, 3, 9 and 21-months and signed by the student, supervisor, interviewers (if annual progress monitoring) and Postgraduate Tutor. The 3, 9 and 21-month pages include sections on the Faculty skills training courses completed and the number of School seminars and conferences attended. The 9 and 21 month pages are included in the annual progress review and are signed by the interviewers.

The number of PhD students starting each year has increased over the last 5 years and this was helped by the School winning a BBSRC DTG in 2007 which funded 6 PhD students (including 3 CASE students). The School is part of the new University BBSRC DTP, especially through its activities in Food Security.

The School is very committed to supporting veterinarians who wish to pursue a career in research. Compared to other UK Vet Schools, Bristol has the highest number of undergraduates intercalating into a science degree programme, and has in recent years been awarded a number of Veterinary Training Fellowships from the Wellcome Trust's CVRT. This includes an intercalated PhD Fellowship, two six year Integrated Training Fellowships (PhD and Residency) and three Research Entry (MRes) Fellowships. The EBI also identifies and supports the best young non clinical and clinical talent through a series of fellowship schemes. Young veterinary clinicians have been recent recipients of EBI research 'taster' awards leading them to subsequently seek funding for Wellcome Trust Clinical PhDs. All veterinary postdoctoral researchers have access to a mentoring scheme provided by the Academy of Medical Sciences.

d. Income, infrastructure and facilities

The success of our research and appointments strategies, and the new procedures to implement them, is indicated by an increase in annual income per member of staff submitted in this exercise (average of £113K/year for REF 2014, £80K/year in RAE 2008). Data submitted as part of Ref 4 show a reduction in total annual research income in the first three years of the period of this assessment, consistent with the reduction in the number of returnable staff described in Ref 5c. However, research income is now stable and the value of research grants awarded (an earlier

indicator of success than annual income), rose in 2012/13. Awards from UK research councils specifically continue to rise and now make up over 50% of the total in 2012/13. This positive trend is set to continue with new staff appointments and replacement of a number of teaching only posts with research appointments (Chanoit, Eisler and Cogan).

Unique/Special Facilities: A number of strategic new developments at Langford have been put in place to support research and the University is committed to ensuring better utilisation of the site as a 'research hub'. The Dolberry building (opened in 2008) accommodates over 80 staff involved in AWB and production animal research. Laboratories used by I&I and C&CR groups are well equipped and have unique expertise and facilities for multi-colour immunohistology and associated data analysis. Quantitative PCR machines are available in both SVS and LVS. Other specialist items of equipment include materials testing machines, *in vivo* and *ex vivo* bone loading devices and a μCT scanner. The I&I group is the repository to one of the largest collection of reagents for pig immune markers in Europe and maintains an SPF piglet isolator suitable for rearing individual piglets in high containment environments. Other large animal facilities at Langford are maintained by Bristol's Animal Services Unit and include high-specification suites with switchable positive/negative filtered airflow, approved for infectious disease studies with organisms up to containment level 3, as well as genetically modified organisms and more conventional suites for behavioural work. A £7.5M surgical and diagnostic clinical facility for small animals, including a 16-slice CT scanner and a 1.5T MRI, and an £3m equine surgical facility have had a very positive impact on case-based research. A state-of-the-art dairy unit (£2M) was recently opened and provides another unique research resource. The pre-clinical translational research centre (due to open in 2015) will play a key role in developing Langford as a site for translational research. Through the FSLRA and Lee's appointment, academics have access to the BBSRC North Wyke Farm Platform. This provides a globally unique range of *in situ* state-of-the-art instrumentation in hydrologically isolated fields and farmlets to address key issues in sustainable agriculture.

University facilities: A number of structures support cross-disciplinary research with which the Vet School is becoming increasingly engaged. As highlighted earlier, **translational research** is supported by **The Elizabeth Blackwell Institute** and **The Cabot Institute** carries out fundamental and responsive research on risks and uncertainty in a changing environment. Research interests include climate change, natural hazards, food, water and energy security, and future cities. The Centre's distinctive approach fuses rigorous statistical and numerical modelling with a deep understanding of interconnected social, environmental and engineered systems – past, present and future. To achieve its vision, the Cabot Institute stimulates linkages across disciplines and with industry and government, developing partnerships, enhancing knowledge exchange across sectors and building groups of shared interdisciplinary expertise. Central to this activity is the External Advisory Board, chaired by former Chief Scientific Adviser Sir John Beddington and leading figures from industry, policy and third sector organisations. Eisler's membership of the executive committee ensures that food security and veterinary research is central to its agenda.

The University's Research and Enterprise Development group works with academic and entrepreneur communities both within and outside of the University. Its multidisciplinary professional teams use their expertise and experience to provide advice and support across the broad and fascinating landscape of research and enterprise activities carried out at Bristol, as well as to projects that are external; including partnerships with other world leading universities nationally and internationally.

The University has a dedicated **Research Governance Team** that is available for advice on how to set up and conduct research projects that involve human participants, their tissue and/or data. They help with the ethics and governance implications of studies by agreeing research governance sponsorship arrangements, advising on the need and process for ethical review, helping with indemnity provision, providing relevant governance training and ensuring standards that enhance research integrity. The University operate a strict policy on working with animals (http://www.bristol.ac.uk/university/governance/policies/animal-policy.html). All projects involving animals are subject to prior formal ethical review within the University, whether or not the procedure is regulated under the Act. Projects involving regulated procedures are submitted to the Home Office for approval; such work only commences once authorised by the Secretary of State.

Members of this submission have access to a range of university core science facilities. The

Wolfson Bioimaging Facility includes a fully-integrated suite of electron, confocal and epifluorescence microscopes, live cell imaging and correlative light and electron microscopy. The **Proteomics Facility** provides a full range of bespoke proteomics allowing the isolation, identification and quantification of proteins in biological samples. The **Transcriptomics Facility** provides expertise and access to the latest genomics and transcriptomics technologies including Illumina next generation sequencing and Affymetrix GeneChip® array analysis. Professor Mika Ala-Korpela is a recent appointment in Social and Community Medicine who leads the **Metabolomics Facility**. The **Centre for Nanoscience and Quantum Information** is a purpose-built facility for conducting high resolution experiments with equipment that includes Atomic Force Microscopes. State of the art rodent facilities are available at Stock Lane Farm near Langford and in the Medical Sciences Building. A new Biological Sciences Building will accommodate members of the parasitology research group from 2014. A recent MRC grant will enable the purchase of *in vivo* uCT scanner and a PET scanner for rodent models (Price is a co-applicant).

e. Collaboration or contribution to the discipline or research base

Academics submitted in this UOA are part of an extensive network of local, national and international collaborations, as highlighted previously. Examples of major international collaborations are three EU-FP7 7 grants (Stokes, Bailey and Day). Members of each research group have involvement in organising national and international meetings and workshops, and many are held at Bristol (e.g. 2013 International Conference on Ruminant Lameness). Because a significant amount of applied research is undertaken within this UoA, academics have a number of well established collaborations with industry (e.g. Nestlé, Pfizer, Amgen, EBLEX, BPEX, Abbott, Meriel, Stonegate UK, Novartis, Morrissons) and influencing bodies (e.g. RSPCA, Soil Association, Farm Animal Welfare Council, FAWC).

Academics contribute to the peer review process in a number of ways (selected examples below):

Editorial board membership: Editor-in-Chief J Comparative Pathology (Day); Associate Editor J Royal Statistical Society Series A, Associate Editor of the Biometrical Journal (Browne); PLoS ONE, BMC Research Notes, BMC Ecology (Gibson); Animal Behaviour (Held); Applied Animal Behaviour Science (Mendl); Research in Vet Science (Murrell); J Feline Medicine and Surgery, Veterinary Clinical Pathology (Tasker). J Small Animal Practice (Chanoit); Parasitology, J Applied Ecology (Morgan); J Veterinary Behaviour (Casey).

Grant committee membership: BBSRC Committee A core group, BBSRC Pool of Experts, NC3Rs Committee (Nicol, Mendl), Programme Review Group of Scottish Govt Rural and Environment Research and Analysis Directorate (Mendl); Petplan Charitable Trust Scientific Advisory Committee (Day); Wellcome Trust CVRT Committee (Price).

Reviewers for national and international grant awarding bodies including; BBSRC, Wellcome Trust, MRC, British Academy, EPSCR, Czech Science Foundation, French National Research Agency, South African National Science Foundation, US Department of Agriculture, Netherlands Organisation for Scientific Research, Croatian Science Board Swedish Research Council.

Membership of learned societies and scientific committees of international societies: Council and executive of the Royal Statistical Society, (Browne); Chairman of World Small Animal Veterinary Association's Scientific and One Health Committees and Vaccination Guidelines Group (Day). Women's Committee of ASBMR (Price). BSAVA Scientific Committee (Casey).

Expert Advisory Panels and Advisory Committees: European Food Standards Agency expert Panel on Animal Health & Welfare, FAWC Standing Committee on Pigs, Poultry and Fish, Defra Transport Evidence Group (Knowles); FAWC Council (Main); NC3Rs Reporting Guidelines Working Group (Browne); Bateson Inquiry into Dog Breeding (Casey); Advisory Board of International Foundation for Science (Stokes); Advisory Council for the Welfare Issues in Dog Breeding, Expert Panel Feline Advisory Bureau (Casey).