Institution: University of Cambridge

Unit of Assessment: UoA6

a. Context

The University of Cambridge's Veterinary School (UCVS) conducts research across a wide spectrum of activities ranging from fundamental biology underpinning biomedical developments in both human and veterinary medicine to work with direct and immediate clinical application. As a consequence, UCVS research has been able to deliver impact to a similarly wide range of non-academic user groups and beneficiaries.
In the **infection and immunity** theme the principal beneficiaries are 1) patients (both human and veterinary) – improving their health and wellbeing through, *inter alia*, the development of novel vaccine targets, improved understanding of disease dynamics and the consequence advances in disease management that have followed, and 2) local and national government and policy making bodies, including the Department of Environmental and Rural Affairs (Defra) resulting in changes to policies and improved public services (for specific examples see cases studies1-3). The **mathematical biology** theme, in particular in the area overlapping infection and immunity, has delivered impact from its research by improving disease control and influencing decision-making by key policy makers through its close working between industry (e.g. the pig industry in the case of swine influenza) and national bodies such as Defra and the Animal Health and Veterinary Laboratories Agency (AHVLA) (in the case of swine flu and bovine tuberculosis - see case study 1). In the **neurosciences** theme, the main area of impact of the research is in improvements to human and veterinary health and delivery of clinical services. For example, work on the mechanisms of remyelination has led to a clinical trial of a regenerative medicine that will commence shortly in human patients with multiple sclerosis (MS). Work on the regenerative properties of olfactory glia has led to a double blinded randomised clinical trial of a cell therapy in clinical spinal cord injury – the first to be performed in any species (see case study 5). In the **comparative pathobiology** theme, there are many examples of work with direct impact on veterinary patients, the welfare and management of domestic species and also in the education of future veterinarians. We have highlighted some of this work in the impact cases studies on canine pancreatitis (see case study 4) and on transport welfare, the latter also having had a profound impact through the formulation of new EU-wide legislation (see case study 3). In the **genetics and oncology** theme the principal beneficiaries have been veterinary patients since they are receiving improved clinical care as a consequence of the development and implementation of new cancer therapies and new diagnostic test for genetic disease. Finally, two additional key user groups researchers in all of the above themes have collaborated and engaged with are a) industry, benefitting both health and wellbeing of human and veterinary patients and the economy and b) the public, enabling research to influence society.

b. Approach to impact

Since 2008 UCVS has undertaken many activities aimed at broadening and implementing the impact of its research programme.

1) Impact on Health/Welfare and Commerce (HWC)

A key approach to impact by UCVS is supporting the translation of research findings into the development of new therapeutic and diagnostic products with the aim of improving veterinary and human patient outcomes. A major resource available to UCVS to help achieve this is ***Cambridge Enterprise Limited*** (CEL)**.** CEL is a wholly owned subsidiary of the University of Cambridge situated adjacent to UCVS. CEL provides guidance on 1) inventions, intellectual property and licensing, 2) business start-up support, and 3) consultancy services. Staff members at UCVS are made aware primarily through the activities of a CEL liaison officer or 'Enterprise Champion' (previously Maskell, currently Bujdoso), whose tasks include organising presentations by CEL staff as part of the department's Seminar programme (see Environment Statement) as well as being a role model for other researchers in how to develop health/economic impact from their research. The University's very generous IP policy (no restriction on further income and generous return to investors) and flexibility in how academic's use their time (subject to them fulfilling their University duties) further incentivises commercialisation activities. Examples of how UCVS has worked with

CEL since January 2008 to achieve health/well-being and commercial impact include: 1) consultancies with GSK, Biogen Idec and Progenitor laboratories (Franklin) and Ipsos MORI (Frost) (handled by Cambridge University Technical Services Limited [CUTS], a subsidiary of CEL); 2) arranging a Medical Research Council (MRC) Confidence in Concepts Award for a regenerative medicine programme at both UCVS and Stevenage Biosciences Catalyst – a 'biotech incubator' site (Franklin), and MRC Developmental Pathway Funding Scheme applications on a hepatitis C vaccine candidate (Heeney) and a Salmonella vaccine candidate (Mastroeni), 3) establishing links with Pfizer Animal Health (now Zoetis Inc.) as part of a BBSRC LOLA programme (Maskell, Tucker), 4) licensing of optokinetic technologies for central nervous system cells (Karadottir); 5) Commercialisation of molecular regeants (Bujdoso); 6) designing and marketing of a device for diagnosis and prognosis of sickle cell disease (Gibson); 7) patent for an ante-mortem blood test for prion disease (Bujdoso) and patent potential for flu-inhibitory transgenes (Tiley) and drug targets for regenerative medicines (Franklin).

2) Industrial collaboration and engagement (ICE)

Complementing CE's activities, UCVS tries to support research collaborations with industrial partners at all stages of research along the translational pipeline, strongly underpinned by the rich and vibrant ***Cambridge Biotechnology Environment*.** Cambridge is an increasingly attractive location for the Biotechnology and Pharmaceutical sector, attracted to the region by the concentration of academic research excellence within the University (Cambridge attracts more than 25% of all European venture capital). UCVS has contributed to the exchanges with existing companies and with the establishment of new companies. Maskell was co-founder of founding of Discuva Ltd in 2011 and a shareholder founder of its spin out company BactEvo Ltd. Franklin has worked closely with two local companies, Neusentis (a Pfizer research unit) and Medimmune (the global biologics research and development arm of AstraZeneca), as part of their regenerative medicine programmes. He has also sub-contracted to Domainex (a Cambridge based drug development company) as part of an on-going regenerative medicine drug development programme.

In addition to individual consultancies (arranged by CUTS), industry engagement with UCVS research has been achieved through both direct grant support and via **Case Studentships**. In the Infection and Immunity theme work has been funded by Pfizer Animal Health (in support of a BBSRC LOLA award – Maskell/Tucker), Zoetis (formerly Pfizer Animal Health) (in support of a BBSRC grant – Bryant), Malta Advanced Technologies Limited (in support of a BBSRC grant – Tiley). Maskell was also awarded a TSB (Technology Strategy Board) grant with the Industrial partner Base4. In the neuroscience theme work on remyelination and axon protection has been funded by Merck-Serono (Franklin). Case studentships have been supported by Genus PLC (Tucker), Pfizer Animal Health (3 - Maskell [2] and Blacklaws), GSK and CEFAS (Pearce), Novartis (Heeney), Zoetis and BQP Ltd (Tucker) and GSK (Franklin).

3) Impact on Public Policy and Services (PPS)

UCVS strongly supports engagement by its academics with policy makers with the aim of improving policies and provisions of services by becoming increasingly evidence-based. For example, Wood closely engaged with Defra and the AHVLA on swine influenza, in leadership of a national multi-agency, multi-institutional (>15) consortium, that he worked to establish at the invitation of major funders (BBSRC, MRC, Defra, Wellcome Trust) in response to the 2009 pandemic. Consortium research results informed appropriate governmental responses. The work on bovine tuberculosis, involving Wood, Conlan, McKinley and Brooks Pollock, identified the key importance of both persistence of infection in cattle in driving the frequent observation of recurrence following controls (~50% of herds after 3 years) (see case study 1).

Engagements and often existing relationships with policy-makers are critical for our research to result in impact on policy. To pro-actively expand our network of contacts, the University hosts ***The Centre for Science and Policy*** (CSaP). Its aim is to help the sciences and technology to serve society by promoting engagement between researchers and policy professionals. Specifically, it provides 1) policy professionals with access to the best academic thinking in engineering, computing, mathematics, the social sciences, law, philosophy and primarily relevant to UCVS, biomedical sciences 2) an arena in which those interested in the policy implications of the sciences and technology, and the relationship between research expertise and public policy, can discuss

and develop new ideas, and 3) training, support and opportunities for researchers to engage with policy makers. Interactions between UCVS and CSaP have been several and are ongoing. For example, several employees from the pharmaceutical sector on secondment to CSaP have engaged with UCVS's MS regenerative medicine programme (Franklin) and many high-ranking civil service and public health officials have engaged with UCVS's mathematical biology programme in relation to epidemic disease control (Wood), as well as with the international Cambridge-Africa programme.

4) Impact on practitioners and services via Continued Professional Education (CPE)
A key mechanism for clinical research and teaching having impact on the veterinary profession and animal health and welfare is through continuous professional development (CPD) courses and seminars run by UCVS staff, which provide the opportunity to impart new developments and knowledge gained through clinical research to the profession. These range from formal taught CPD courses such as an annual one week Advanced Small Animal Medicine course run in UCVS, most recently attended by 30 delegates, to more *ad hoc* evening seminars on a range of topics and species for local veterinarians both in house and by staff visiting local practices. The imaging group at UCVS runs a once weekly film reading evening for local practitioners, which serves to enhance UCVS's relationship with local practices educationally and assists provision of clinical case material. Many clinical academic staff of UCVS are key CPD providers as invited speakers / tutors at national and international CPD events, such as British Small Animal Veterinary Association (BSAVA) Congress, attended this year (2013) by over 5,000 delegates, 6 members of clinical staff were invited speakers at this show case event for the UK small animal veterinary profession. The major national equine veterinary CPD provider is the British Equine Veterinary Association and Henson has chaired their CPD committee through the period under review. Many staff also actively participate in the specialist colleges and their annual conferences e.g. American College of Veterinary Internal Medicine, European College of Veterinary Internal Medicine, European College of Veterinary Surgery, European College of Veterinary Neurology etc., are authors/editors of books such as the BSAVA Manual series, and are increasingly involved in Web-based learning e.g. WebinarVET.
The UCVS is also committed to professional development through professional outreach programmes, where practicing vets are encouraged to engage in research programmes of their own with support from UCVS staff. We have been running a week-long residential course, initially biannually and now annually, that provides veterinary clinicians with the insight, knowledge and skills to start planning and organizing their own clinical research projects. Over the period, 90 vets have been on this and many projects, grants and publications have been produced or improved as a result.

5) Public engagement as a route to influencing society, culture and creativity (SCC)
An important avenue through which UCVS achieves impact for its research amongst non-academic user groups, beneficiaries or audiences is through public engagement. Public engagement activities include: 1) annual open days showcasing the diversity of UCVS research during the annual Cambridge Science Festival; 2) regularly updated news items on the UCVS website; 3) in house and external seminars for Canine breed clubs and societies and educational talks at "Friends Open Days" hosted by the University of Cambridge Veterinary School Trust; 4) working with the University's Office of External Affairs and Communications (OEAC). OEAC have arranged press releases for many UCVS research outputs, several of which have attracted considerable media exposure and debate. This included live and recorded national radio coverage on the Today Programme, Farming Today and Material World, BBC Radio 4 – of topics such as MRSA in milk [Holmes], transgenic chickens' resistance to avian influenza [Tiley], regenerative medicines for MS [twice – Franklin], cell therapies for canine spinal cord injury [Franklin]. Some of these topics also made national television news (transgenic chickens' resistance to avian influenza; cell therapies for canine spinal cord injury) and were picked up by national newspaper reports (all of the above, plus work on sex specific immunity received widespread attention [Restif]).

c. Strategy and plans

UCVS has put increasing emphasis on maximising the impact of its research and since 2008 has developed a strategy by which this will be achieved and which we will continue to implement over

the next assessment period. UCVS believes that there is a critical role in creating an environment where the delivery of impact by investigators can be facilitated and optimised. Central to the strategy has been a policy of increasing the awareness amongst UCVS academic staff of the available mechanisms for achieving impact and of the importance of impact of our research. Our plan is for UCVS research to have a major influence on society by innovation-driven development of new treatments in human and veterinary medicine, influencing policymaking at national and international levels and engaging with the public to increase their understanding and where appropriate influence their attitude to scientific findings.
Our strategy to achieve this includes:
1) Regular (>annual) presentations by CEL staff to UCVS about services offered (section b) to increase awareness of structures to support impact activities.
2) Continuation of a UCVS '**Enterprise Champion**' (currently Bujdoso) who provides a communication channel between CEL and UCVS academic staff. The Enterprise Champion meets every other month with staff members of CEL to be appraised of new developments pertinent to the commercialisation of research and other CEL services. The Enterprise Champion then relays these to UCVS staff. An example as successful mediation by the Enterprise Champion is the licensing of imaging and optokinetic technologies for CNS cells (Karadottir)
3) Continued use of the University's and Cambridge Enterprise commercialisation/translational pump-priming funds, such as BBSRC Sparking Impact, MRC's Confidence in Concept and the EPSRC Impact Acceleration Award.
4) Training provided by staff from the University of Cambridge **Research Operations Office** to UCVS staff on how to successfully develop 'pathway to impact' component of UK Research Council applications (organised by UCVS research grants officer).
5) Liaison with OEAC regarding key UCVS research outputs to maximise engagement with a wide audience through press release and media coverage.
6) Continued engagement with CSaP to grow the network of policy contacts.
7) Continued engagement with key strategy and policy makers in health and biomedicine (e.g. DEFRA, major finding bodies such as BBSRC, MRC and Wellcome Trust) to ensure research findings feed into policy decisions.
8) Advances in the clinic will be disseminated to the profession through presentation of research at international meeting and publication in veterinary journals to influence clinical practice.

d. Relationship to case studies

As part of UCVS's REF submission we have submitted 5 case studies (CS) illustrative of the different types of impact that UCVS has achieved across the spectrum of its research activities. **CS1**, 'Improving use of available controls against bovine tuberculosis', illustrates impact activities HWC and PPS, and has addressed critical evidence gaps (lack of clarity on effectiveness of cattle controls used in Britain) to allow improved evidence based policies for managing this economically and societally important cattle disease. **CS2**, 'A new MRSA emerging in human and bovine populations' illustrates impact activities in HWC and PPS. It is representative of a broad programme of work with impact in both disease management (e.g. vaccine development and strategies) and informing governmental policy relating to animal health. It exemplifies how we have used careful field observations to develop a major programme resulting in transformed protocols for MRSA detection. **CS3** 'Farm animal welfare – changes to policy and practice', illustrates impact activities in HWC and PPS, achieving widespread impact through the creation of new EU-wide legislation. Animal welfare has been an important UCVS research area over many years and has provided pivotal evidence for UK/EU animal welfare policy. **CS4**, 'Improving recognition and treatment of chronic pancreatitis in dogs', provides an example impact activities in HWC and CPE, describing the discovery of new clinical entities that have improved patient care and changed both veterinary education and practice. **CS5** 'Cell therapies for spinal cord injury' also illustrates impact in HWC, CPE and SCC. Much of the work within the neurosciences theme is ultimately directed towards new therapies for CNS diseases (primarily demyelinating disease such as multiple sclerosis (MS), traumatic injury such as spinal cord injury and degenerative diseases including prion disease). The discoveries made are at different stages of the translational pipeline, but all have a forward momentum towards the implementation of new treatments in both humans and veterinary species.