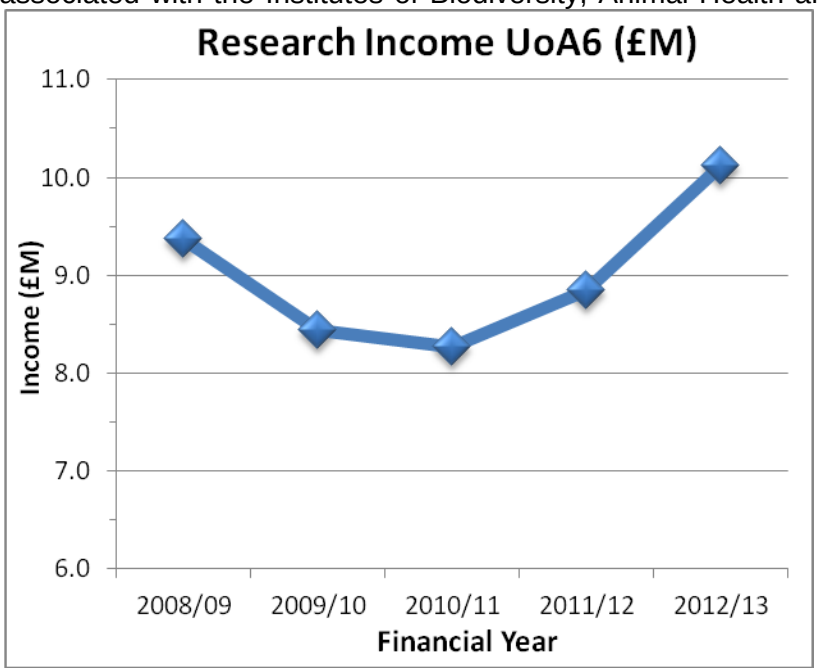
**Institution: University of Glasgow**

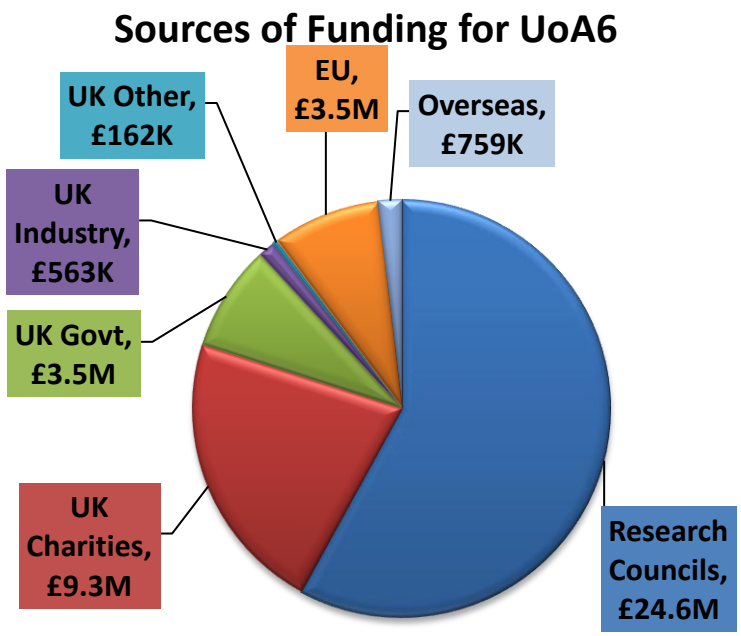
**Unit of Assessment: Unit 6; Agriculture, Veterinary and Food Science**

## a. Overview

The 40 academic members of staff reported in UoA6 are members of the College of Medical, Veterinary and Life Sciences (MVLS). MVLS was founded in 2010, bringing together three former biological and biomedical faculties and it now includes seven research institutes and three schools (Medicine, Veterinary Medicine, and Life Sciences). The bulk of the University of Glasgow UoA6 submission relates to animal health and animal science, and is considered as two large research groups: Infectious Disease, and Comparative Medicine and Biology. The submission includes staff associated with the Institutes of Biodiversity, Animal Health and Comparative Medicine (BAHCM), and Infection, Immunity and Inflammation. Researchers in UoA6 also work closely with members of Cancer Sciences and Cardiovascular and Medical Sciences. The reconfiguration into schools and institutes has facilitated a "One Health" approach to research and postgraduate training. Rather than pursuing independent research agendas within their professional discipline areas, veterinary and animal health researchers are working in cross-disciplinary groups, enabling more efficient use of resources and greater potential to gain insights of broader significance to the "One Health" agenda.




Increased focus on quality of research, formalised in the transition to an institute-based structure, has resulted in improved research performance and an improved research environment. Importantly, we have focused on our areas of strength: Infectious Disease, and Comparative Medicine and Biology. As a result of our renewed focus, research income for UoA6 has grown substantially and it now generates over 9% of the research income for the entire College of MVLS. In addition we made considerable infrastructural development including construction of the MRC-University of Glasgow Centre for Virus Research (CVR, £20M; infrastructure development supported by the MRC, £6M), the Wellcome Trust (£4.8M) and the University of Glasgow (£10M), the construction of a large animal facility to house the Scottish Centre for Production Animal Health and Food Safety (£2.8M) and an award-winning Small Animal Hospital (£13.3M). Major recent awards include strategic grants from the MRC to establish the CVR (£5.26M, **Palmarini, Willett, Haydon, Nasir, Cleaveland, Hosie**), a £2.5M senior investigator award (**Elliott**), a £1.65M senior fellowship (**Macleod**) and a £1M Programme Grant (**Palmarini**) each from The Wellcome Trust.




**Research Groups**

Within UoA6, there are two broad and approximately equally sized research groups: (1) Infectious Disease and (2) Comparative Medicine and Biology. The main areas of activity in Infectious Disease are the ecology of infectious disease, viral diseases, and parasitic diseases. Within the Comparative Medicine and Biology Group areas of strength include physiology and reproductive biology, and production animal and public health. Because of the unique balance of clinical and non-clinical researchers in our return to UoA6 and the support given to cross-disciplinary collaboration, each of these areas of strength is well represented across the spectrum from basic to applied or translational research.

**Research Group 1: Infectious Disease**

***Ecology of infectious disease***

This is a rapidly growing area of research at the University of Glasgow and includes the quantitative analysis of disease ecology, the investigation of problems relating to zoonoses, emerging diseases, animal and ecosystem health, and the analysis of infection reservoirs as a central component in the study of endemic disease. These activities require the effective integration of rigorous quantitative analysis, development of appropriate theoretical frameworks and predictive modelling of empirical data ranging from molecular genetic analyses through to observations on human activity. The researchers in this area include molecular biologists, ecologists, epidemiologists, food animal veterinarians with a strong clinical and veterinary public health orientation as well as mathematicians, statisticians, engineers and physicists. Recent research highlights in this area include:

- Demonstration of a high level of phenotypic and genetic heterogeneity of human and animal outbreaks of *Salmonella* Typhimurium DT 104 (**Mellor, Haydon**, Science, 2013)
- Prediction of the public health benefit from vaccination of cattle against *E coli* O157 (**Matthews, Reeve**, **Haydon**, PNAS, 2013)
- Application of *Mycobacterium bovis* whole genome sequencing to unravel the transmission patterns of tuberculosis among herds of cattle and associated badgers (**Kao**, PLoS Pathogens, 2012)

***Viral Disease***

The MRC-University of Glasgow CVR was established in 2010 with infrastructure and operational funding from the Medical Research Council, the University of Glasgow and the Wellcome Trust and includes researchers focusing on human viral diseases (returned largely in UoA1) and those focusing on animal viral diseases (returned here in UoA6). The CVR capitalises on a great legacy of veterinary virology research at the University of Glasgow and takes the (One Health) view that the biology underpinning virus science is common to both human clinical and veterinary medicine. The Director of the CVR is a veterinarian (**Palmarini**). Research at the CVR spans molecular and cellular levels through to the individual host and affected populations where it integrates seamlessly

with the Ecology of Infectious Disease grouping. Highlights since 2008 include:

- Use of retrovirus integrations to determine the history of sheep domestication (**Palmarini, Kao, Stear**, Science, 2009)
- The evolution of complex retroviruses and its implication for lentivirus evolution and dispersal (**Gifford**, Science, 2009; PNAS, 2008; PNAS, 2012)
- The evolutionary history of avian reticuloendotheliosis viruses (**Gifford**, PLoS Biology, 2013)
- Transmission and evolution of equine influenza virus (**Murcia**, PLoS Pathogens 2012a and 2012b)
- Insect vector innate immunity to arbovirus infection (**Kohl, Schnettler**, PLoS Pathogens, 2012; **Kohl**, PNAS, 2010)
- Determination of the ultrastructure of orthobunyavirues (**Elliott**, PLoS Pathogens, 2013)
- Elucidation of the pathogenesis of emerging viruses of livestock and their interaction with the innate immune responses (**Palmarini**, PLoS Pathogens, 2013; PLoS Pathogens 2011)

***Parasitic disease***

Parasitology research is another long term strength of the University of Glasgow and includes a strong veterinary/comparative contribution in addition to human parasitology submitted under UoA1. Researchers in UoA6 are prominent in the fields of parasite genetics and genomics, host resistance to nematodes and ticks and drug resistance in nematodes and cattle ticks. Recent research highlights include:

- Publication of the first genome from a trichostrongylid nematode, the important sheep and goat parasite *Haemonchus contortus* (**Britton, Devaney**, Genome Research, 2013)
- Discovery of the genetic basis of resistance to amitraz acaricides in the cattle tick, *Rhipicephalus microplus* (**Jonsson**, PNAS, 2013)
- Elucidation of the mechanisms of Trypanosome resistance to human trypanosome lytic factor (**Macleod**, PNAS, 2010)
- Definition of the molecular mechanisms driving host transformation of *Theileria annulata* in cattle (**Shiels**, PLoS Pathogens, 2010)

**Research Group 2 Comparative Medicine and Biology**

This research group is involved in research in physiology and reproductive biology and production animal and public health. Strong research themes include the physiological control of reproduction, effect of environmental toxicants on development, poultry welfare and proteomics. Research highlights from the assessment period include:

- The demonstration of a role of polyubiquitin binding to ABIN1 in the prevention of autoimmunity (**Patterson-Kane**, J Exp Med, 2011)
- The development of a new bioinformatic method (association weight matrix) for analysis of complex traits such as time of onset of puberty in livestock (**Jonsson**, PNAS, 2010)
- The demonstration of a disruptive effect of sewage sludge on the Kisspeptin/GPR54 system in the sheep brain and consequent reproductive impairment (**Bellingham, Evans**, Env Health Persp, 2009)

**b. Research Strategy**

***Achievement of strategic objectives for research 2008-2013***

The mission for UoA16 (the predecessor of UoA6) in RAE 2008 incorporated three objectives: (1) To integrate research activities across the broad field of research encompassing infectious and genetic diseases of animals and man, (2) To develop novel animal models of human disease, and (3) To foster translational research in veterinary medicine. In 2008 the vehicle for attaining these objectives was the Institute for Comparative Medicine (ICM), within the Faculty of Veterinary

Medicine. The creation of the College of MVLS transformed the ICM onto a larger scale and increased the scope of the collaborations that the ICM was established to promote, thereby achieving the first objective. The establishment of the CVR led by a veterinarian, funded by MRC and investigating viruses of importance to human and animal health is a clear example of integrated animal and human health research. The second objective has been achieved in large measure by the reproductive biology group (**Evans, Robinson, Mihm, Hastie, O'Shaugnessy, Bellingham**) whose work is almost all of a comparative nature, with a strong focus on toxicology. **Evans, Robinson** and **Hastie** primarily use the sheep as a model for the effects of environmental toxins on reproductive function. The third objective has been addressed by sustained investment in the support for quantitative biologists, by the recent establishment of the Glasgow Polyomics Facility, which houses state of the art genomic, transcriptomic, proteomic and metabolomic equipment and is well staffed with bioinformaticians, by the establishment of the Boyd Orr Centre for Population and Ecosystem Health, and by strengthened collaborations with the Moredun Research Institute (MRI), Scotland's Rural College (SRUC) and the University of Edinburgh. These collaborations have resulted in larger and more effective project grants from the Scottish Government and the Department for Environment, Food and Rural Affairs (Defra). An example of successful translational research is the EPIC programme (the Scottish Government's Centre of Expertise on Animal Disease Outbreaks), a £10M project partnership between the University of Glasgow (**Kao, Matthews, Mellor, Zadoks**), with the University of Edinburgh, Biomathematics & Statistics, Scotland, the James Hutton Research Institute, the Roslin Institute, the MRI and SRUC (the lead group for the project). The overarching purpose for EPIC is to provide access to high quality advice and analyses on the epidemiology and control of animal diseases that are important to Scotland and to best prepare Scotland for the next major animal disease incursion. University of Glasgow Postdoctoral Research Assistants and postgraduates are based at the University and the Scottish Government offices in Edinburgh.

***Future strategic objectives for research***

Development within UoA6 is focussed on achieving excellent research outputs with a positive impact on Scottish, UK and international problems relating to human and animal health (One Health) and food security. We aim to conduct research that addresses real problems in livestock, companion animal and ecosystem health, which makes use of truly novel approaches and will serve as a template for other researchers to follow. To achieve this aim, we;

- Have identified our areas of strength and are investing in the development of those areas, while disinvesting in areas where there is less concentrated capacity and where challenges are considered to have less strategic importance.
- Are maximising the interaction with and use of the Glasgow Polyomics Facility for access to advanced biotechnologies to support all areas of our research.
- Have strengthened our relationship with the MRI and the Pirbright Institute through joint appointments, collaborative grant applications, and jointly funded PhD programmes.
- Continue to develop partnerships with the pharmaceutical industry, government agencies and other academic consortia in UK and EU to enhance impact delivery.
- Partner veterinary clinical researchers with established researchers of excellent international reputation to improve the quality of clinical research and impact of basic research that has potential clinical application.
- Have centralised the management of postgraduate research students at the College level to ensure a similar high standard of research supervision across all areas of activity.
- Are building robust interactions with user groups, including national and international government agencies and policy makers, non-government organisations, and professional groups.

- Continue to develop fit-for-purpose infrastructure for research, as demonstrated in this assessment period through the construction of the CVR, large animal facilities and one of Europe's best small animal veterinary clinical facilities, equipped with the best diagnostic and therapeutic equipment available, all within close proximity to the Glasgow Polyomics Facility.

***Achieving the specific objectives***

Our specific objectives (SO) are listed below, together with the means by which we intend to achieve them and some examples where relevant.

***SO1. Advance the understanding of the ecology of disease within ecosystems, developing novel methods of analysis of biodiversity and quantification of health in ecosystems.***

- **The Boyd Orr Centre for Population and Ecosystem Health** is a platform for the interaction of scientists drawn from diverse backgrounds within the University community. It has recently been awarded a Queen's Anniversary Prize for its achievements in linking wide-ranging research projects from population and landscape ecology to epidemiology, immunology, and population genetics, and the impact of its work on infectious diseases. It is the focal point for seminar series, journal clubs, extra-curricular activities, blog site and many informal opportunities for scientists to interact and generate new ideas for productive collaboration. This has stimulated very close and effective interaction between ecologists and those with a veterinary or animal production background. (e.g. **Matthews, Reeve, Haydon**, PNAS 2013; **Mellor, Haydon**, Science, 2013; **Palmarini, Kao**, Science 2009).
- **Critical mass in quantitative methods**: Mathematical models are fundamental to the study of ecosystems and disease in populations, so a central component of strategy has been to develop a strong, core group of mathematicians and epidemiologists (**Cleaveland, Haydon, Kao, Matthews, Mellor, Reeve**), within BAHCM and recruit mathematically literate veterinary researchers (**Denwood, Zadoks**).
- **Increased use of the University's Cochno Farm**, an upland grazing farm representative of UK Less Favoured Areas, for grazing livestock ecosystems research. With the establishment of BAHCM, we are now able to exploit this resource for integrative studies of livestock production in an ecosystems context.

***SO2. Conduct clinically oriented research in livestock contributing to food security, food safety and carbon-efficient production, aligned with MVLS areas of strength in ecosystem health, population biology, infection, immunity and inflammation.***

- **Centre for Virus Research (CVI)**: The creation of this Centre represents a new focus for virology research in the UK. Partnership funding from the MRC and the Wellcome Trust underpins the primary objective of bringing medical and veterinary researcher leaders together to tackle diseases of humans and animals and anticipate future risk regardless of origin. As such it is a strategic response to the evolving threat to public health, food security and economic growth presented by viral diseases. Areas of priority include RNA viruses and arboviruses. Molecular biological approaches are strengthened by recruitment and integration of bioinformatics, epidemiologists and mathematical modellers.
- **Establishment of the Scottish Centre for Production Animal Health and Food Safety (SCPAHFS)**: In 2009, the University constructed a £2.8M building for SCPAHFS, where 30 adult cattle and as many sheep can be housed. Since 2009, we have recruited a Director (**Jonsson**), 1 researcher (**Denwood**), 3 clinicians, and are recruiting another researcher. SCPAHFS is now the focus for food animal clinical research at the University of Glasgow.
- **Collaboration with the Moredun Research Institute (MRI)**: MRI was established with the aim of improving the health and welfare of livestock in Scotland. The University has a long-standing memorandum of understanding with MRI and we have many, close collaborations and one joint appointment (**Smith)**. There are currently 5 jointly supervised PhDs enrolled at the University of

Glasgow, and over the period 2008-2012, the collaboration has produced an increasing volume of co-authored, peer reviewed research papers, rising from 7 and 8 in 2009-10 to 12 and 14 in 2011-12.

- **Collaboration with Scotland's Rural College (SRUC):** SRUC is the home of much of Scotland's capacity in agricultural research. We have several effective collaborations with SRUC. Within the area of production animal health and welfare, examples of effective collaboration include EPIC *(***Kao, Matthews, Mellor**); Paraban, a knowledge exchange project on the management of bovine Johnes disease (**Mellor**); sub-acute rumen acidosis (**Jonsson**); humane euthanasia of poultry (**McKeegan**); acute phase proteins as indicator of pig health status (**Eckersall**).

***SO3. Invent new approaches to diagnosis, prophylaxis and therapy for animal health problems in all species and develop technology that links advances in sensor systems, imaging, and bioengineering with recent advances in animal biology in health and disease.*** Recent innovations in this area include the development of new vaccines against viral diseases of livestock (**Palmarini**), and the EU COST Action 1002 Farm Animal Proteomics (**Eckersall**) in the discovery and application of biomarkers of health and performance, discovery of genetic markers for synthetic pyrethroid and amitraz resistance in the cattle tick (**Jonsson**).

- **Innovation Centre for Sensor and Imaging Systems (ICSIS)**: we are actively developing interactions between veterinary clinical researchers and the ICSIS to promote the development of new technologies for health management of animals.
- **Entrepreneur in residence**: the appointment in 2012 of an Entrepreneur in Residence in MVLS will assist in the whole process of innovation and development of new products.

***SO4. Conduct high quality basic laboratory science that defines molecular and cellular mechanisms in normal physiology, and that subsequently underpin the development of animal diseases.***

- Fundamental to this objective is providing the correct infrastructure, support and applying the correct drivers, all as listed in the section above.

***Mechanisms for promoting and disseminating research and for developing our research culture***

The College has a number of mechanisms for promoting research that have benefited staff members submitted within UoA6. These include;

- **Lord Kelvin Adam Smith studentship scheme**: Designed around projects of an interdisciplinary nature. UoA6 has benefited from 7 of these fully-funded PhDs since 2008.
- **Laboratory animals:** MVLS has initiated a competitive scheme for staff for up to £10k to support in vivo experiments using laboratory rodents, to enhance the scientific merit of research and to provide preliminary data to support more substantive grant applications. MVLS has also made a contribution of £1M to defray the costs of *in vivo* experimentation, reducing animal tariffs by over 30%, making *in vivo* experimentation more attractive to external funding agencies.
- **Glasgow Polyomics Facility**: This newly established facility has introduced a series of competitive grants under the Institutional Strategic Support Fund of The Wellcome Trust. These include a Fellowship Programme, a Catalyst grant scheme (internal competitive fund up to £30k per applicant), and short term support. UoA6 was the most successful of any group in the first round of this programme in 2013, dramatically improving the accessibility of cutting edge technology for our researchers.

**c. People, including:**

**I. Staffing strategy and staff development**

***Staff Development***

UoA6 staff benefit from a comprehensive University of Glasgow staff development programme, and from specific initiatives that focus on particular discipline-specific requirements. The high standard of the environment from a staff development perspective is indicated by the **EU HR Excellence in Research Award** – The University was one of the first universities to be awarded the 'HR excellence in research' award in 2010 from the European Commission, in recognition of its commitment to supporting its researchers' career, personal and professional development and management. Other University-wide initiatives that contribute to the development of research staff include the **implementation of the Concordat to Support the Career Development of Researchers**. The University's Concordat implementation plan includes;

- Links with institutional monitoring: to monitor appraisals and ensure all staff benefit from an annual appraisal, to ensure effective induction of new staff and additional functionality for monitoring participation in training.
- The University's Code of Practice for the Management of Research Staff outlines responsibilities of researchers, PIs and Schools.
- Implementation of the Researcher Development Framework, including piloting the *Vitae* online planner tool.
- A specific Performance and Development Review form for researchers.
- Mentoring, online resources, training workshops and mock interviews for research staff applying for internal or external Fellowships.

***Developing the research of early career researchers***

We focus on developing our own researchers, and recruiting new candidates to provide novel opportunities. Examples of specific investments in increasing early career opportunities include:

- **Lord Kelvin Adam Smith Fellowships**: In 2012, the University invested over £7M to support the appointment of Lord Kelvin Adam Smith Fellowships, providing salary funding (3-5 years) and £30-50k in additional research support. One fellow was appointed to UoA6.
- **Travel scholarships for staff and research students**: The University provides a variety of travel scholarships for staff and students including the John Robertson Bequest, which supports pump priming, travel and blue sky ideas. Mac Robertson Scholarships provide funding for postgraduate research students to study at a centre of advanced study. UoA6 researchers received support to the value of £14K since 2008.

***Developing clinical researchers and their activities***

New appointments to the clinical academic team are made in consideration of the research strengths in the College. This process is also facilitated by the introduction of the Vetfund, a fund for clinical research, supported by donations to the University, commencing in 2013. The first call saw 20 applications, of which 12 are expected to be funded, to a value of £46K.

***Support for Equality and Diversity***

The University of Glasgow has invested heavily in achieving our equality and diversity objectives.

- **Athena Swan Bronze Award**: The University has set a key performance indicator in its strategy 'Glasgow 2020: a global vision' to increase the percentage of women in senior administration and professorial posts and provides support to MVLS applications.
- **Equality & Diversity Training:** The University offers two online equality and diversity training courses and has embedded this into all of its management and leadership courses.

**c. II. Research students**

Basic, translational and clinical research within UoA6 benefited from a variety of training programmes funded by national and international agencies. All PGR is administered via a unified

MVLS Graduate School. This provides a high quality PGR and PGT learning environment, training skills; providing conferences; seminars; workshops and publications. The Dean of Graduate Studies has primary responsibility for academic matters in relation to postgraduate studies.

**Researcher Development Programme**

Building on the successes of the Roberts funding, the University now invests £300K per annum in training and development opportunities for PGR students. Cross-College opportunities are coordinated by a dedicated Researcher Development Officer with additional discipline relevant training managed by the College Graduate Schools. Since 2008 training has focussed on providing activities to fit the RCUK Joint Skills Statement (and latterly the Researcher Development Framework) while also enabling our students to engage nationally and internationally with their peers. University of Glasgow-originated training packages have been shortlisted for Times Higher Education awards (Making an Impact with your PhD, 2010). Glasgow collaborated in a Scotland wide programme, focused on training for knowledge exchange, which received a THE award in 2010.

**d. Income, infrastructure and facilities**

**Income**

From 2008-13 the staff submitted to UoA6 earned £45M in external research grant income, which equates to £232K per FTE per annum, more than twice the Russell Group median for the veterinary science subject area and exceeding the bioscience area (11/12 HESA data). Of this, over 60% is derived from the Research Councils, 20% UK charities and 9% from government with the remainder from a variety of funders including industry.

**Infrastructure and Facilities**

Staff and students enjoy access to a range of modern high quality laboratory accommodation and facilities that support research across the range of experimental disciplines. Significant investments have further enhanced quality and capacity since 2008.

- **Sir Henry Wellcome Building for Comparative Medical Sciences**: Was completed just before the current review period at a cost of £7M and was designed to link two existing research buildings allowing the resulting research complex to be managed and supported as a single large unit. The complex houses core equipment including: confocal and electron microscopes; category II/III containment suites; flow cytometers; as well as a dedicated insectary.
- **The MRC-University of Glasgow CVI**: Is due for completion in 2014. It will unite medical and veterinary virology research and will act as an important locus for future funding and recruitment. The new centre has been realised through a £20M capital investment jointly funded by the MRC, the University of Glasgow, the Wellcome Trust and Wolfson Foundation.
- **Cochno Farm and Research Centre**: Has benefitted from considerable investment in recent years and provides crucial support for our ruminant and poultry research. This well-equipped 800 acre research farm ranges over 200m of elevation, making it a great resource for both farming and ecosystems studies.
- **Glasgow Polyomics Facility**: With matched funding from The Wellcome Trust, the University has invested heavily in the development of Glasgow Polyomics. This excellent facility boasts the latest equipment and is supported by an integrated network of large data experts, allowing researchers access to a range of technologies including deep sequencing; metabolomics; transcriptomics; proteomics and epigenomics.
- **Animals**: Staff enjoy access to high quality and extensive animal house facilities – the Central Research Facility and the Veterinary Research Facility, operated and managed by dedicated staff including site based NACWOs and two veterinary surgeons.

- **Veterinary clinical facilities**: Farm animal clinical studies are facilitated by the new Scottish Centre for Production Animal Health and Food Safety, which was completed in 2009 at a cost of £2.8M, and the Small Animal Hospital, a £13.3M investment also completed in 2009.

**e. Collaboration and contribution to the discipline or research base**

**Recognition and Awards**

University of Glasgow researchers in UoA6 are well regarded in their fields. There are 4 Fellows of the Royal Society of Edinburgh (**Cleaveland, Elliott, Haydon, Palmarini**). **Palmarini** was awarded the Royal Society (London) Wolfson-Royal Society Research Merit Award and is a Fellow of the Society of Biology. **Cleaveland** was awarded the John E McCoy Distinguished Lectureship at Washington State University in 2010 and the Trevor Blackburn Award from the BVA for overseas veterinary research work in 2008.

**Funding bodies/Learned/Professional Societies and Associations**

Staff serve or have served on panels and committees of The Wellcome Trust (**Cleaveland, Palmarini**), BBSRC (**Devaney, Matthews, Palmarini, Willett**), MRC (**Devaney**), British Society for Neuroendocrinology (**Evans**), Horserace Betting Levy Board (**O'Shaughnessy**), Defra (**Matthews**) Association for Veterinary Teachers and Research Workers (**Eckersall, Denwood**), British Veterinary Association (**McKeegan, Jonsson**), European Society for Virology (**Elliott**), the European College of Bovine Health Management (**Jonsson**), Department of Agriculture, Food and the Marine, Ireland (**Mihm-Carmichael**) and the International Association of Ecology and Health (**Cleaveland**).

**Government and public advisory committees**

UoA6 researchers maintain effective collaborations with government and other public agencies, resulting in some significant appointments, some representative examples of which include: **Mellor** is a member of the Department of Health Advisory Committee on Dangerous Pathogens, is the Health Protection Scotland representative on Human Animal Infection Risk Surveillance Committee, and a member of the Defra Antimicrobial Resistance Coordination Group, as well as being a member of the Scottish Government Strategic Management Board for Veterinary Surveillance. **Devaney** is a member of the Board of Directors of the MRI and is on the Steering Committee of the Scottish Government's Strategic Partnership for Animal Science Excellence. **McKeegan** is an expert member of the European Food Safety Authority Working Group on Harvesting Feathers. **Jonsson** was on the Australian Animal Welfare Strategy R&D Working Group (2008-9) and a member of the FAO Working Group on Parasite Resistance (2003-8). **Cleaveland** is a member of the WHO International Health Regulations Emergency and Review Committee and the WHO Advisory Panel on Zoonoses.

**Journals**

UoA6 staff are editors or associate editors for journals including Andrology, Virology, BMC Veterinary Research, PLoS Neglected Tropical Diseases, and serve on the editorial boards of many journals including Animal Reproduction Science, Annals of Tropical Medicine and Parasitology, Biology of Reproduction, Endocrinology, Journal of General Virology, Journal of Helminthology, Journal of Molecular Endocrinology, Journal of Virology, Reproduction, Parasitology, The Veterinary Journal, Veterinary Microbiology, and Virology.

**Major International Collaborations**

**Tanzania**: A significant proportion of the research activity in BAHCM is based in Tanzania, in close collaboration with Tanzanian research institutes including the Tanzanian Wildlife Research Institute and the Nelson Mandela African Institute of Science and Technology (NM-AIST). NM-AIST provides a valuable partner for "One Health" science, given its proximity to a range of unique

ecosystems and range of local agro-ecosystems.

**Afrique One**: The Wellcome Trust African Institutes Initiative has funded Afrique One (http://www.afriqueone.net/) for which University of Glasgow researchers serve as northern partners. The consortium comprises 11 African institutions from 6 different countries in east and west Africa. Six of the Institutions are from Tanzania.

**Paul Allen School of Global Animal Health**: BAHCM staff work closely with the Paul Allen School of Global Animal Health at Washington State University (WSU) in Pullman. Joint research in Tanzania is supported by two NSF-BBSRC grants, an annual seminar given at WSU by a University of Glasgow researcher, and sabbatical visits.

**Pirbright Institute**: Collaborative research on foot-and-mouth disease virus (FMDV) and blue-tongue virus has been or is supported by several jointly held grants from the BBSRC (3), Defra (2) and the Wellcome Trust (1). Pirbright and the University of Glasgow share several PhD students (5 currently, and 2 graduated since 2008). The collaborations on FMDV have produced 9 research papers since 2008 including the first application of high throughput sequencing to FMDV, the description of within host viral diversity, molecular epidemiology of transmission, and the reconstruction of transmission trees from genetic and epidemiological data.

**Mill Hill**: Research on human influenza is conducted in collaboration with WHO Collaborating Centre for Reference and Research on Influenza at the MRC National Institute for Medical Research, Mill Hill, where Institute staff and students are regular visitors. The Director of the Centre, John McCauley, is a visiting professor in BAHCM.

**EPIC**: Members of BAHCM partner in the multi-institutional Scottish Government funded Centre of Expertise for Animal Disease Outbreaks, and lead a consortium (with Warwick and SRUC) forming part of Defra's Quantitative Modelling Standing Capacity.

**COST**: **Eckersall** is Chair of the EU COST Action 1002 Farm Animal Proteomics in the discovery and application of biomarkers of health and performance.

**PARAVAC Consortium**: EU-funded (€9M, University of Glasgow share £280K) on helminth antigen discovery (**Britton**).