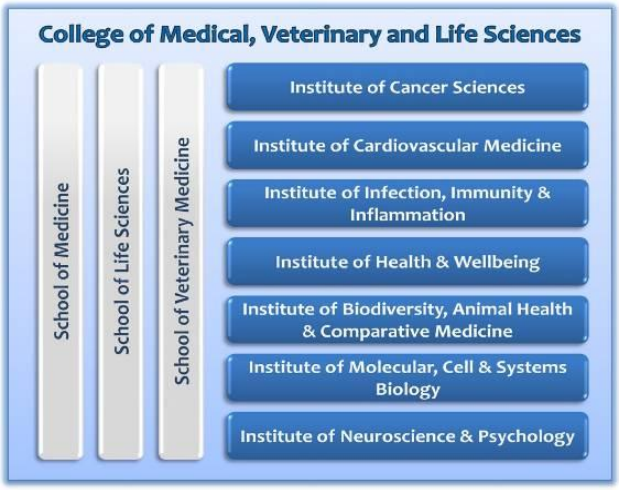
Institution: University of Glasgow
Unit of Assessment: Unit 1; Clinical Medicine
a. Overview

Staff reported in UoA1 are members of the **College of Medical, Veterinary and Life Sciences (MVLS)** at the University of Glasgow. Recognising the imperative for collaborative and cross-disciplinary approaches to solve major challenges in biomedical science, the University dissolved its traditional tri-Faculty structure (Medicine, Veterinary Medicine, Life Sciences) to create the College of MVLS, comprising 3 Schools and 7 research Institutes (see figure). This restructuring in 2010 has brought significant benefits for both research and enterprise activities with major University investments in MVLS personnel (67 senior academics and 131 Early Career Researchers (ECRs) recruited since 2010) and infrastructure (£105 million invested in research infrastructure and facilities since 2010). The multi-disciplinary ethos of MVLS has had a major impact on our recent success rates in national and international funding with total extramural funding won since 2008 totalling more than £625 million.

MVLS provides an environment for clinical, translational and basic research through strategically aligned thematic Research Institutes that, in turn, support the overarching research priorities of the College and University. Institutes do not distinguish between clinical and non-clinical disciplines and thereby provide an assimilated and seamless environment for fundamental discovery science to inform translational and clinical research and *vice versa*. **This environmental transformation has generated critical academic mass and has catalysed accelerated achievement of the key strategic objectives set for the current assessment period**. The MVLS structure has facilitated improvements in research quality, strategic recruitment of highly productive academic staff and matriculation of increased numbers of PhD students. Critically, new research fellows aligned to our priority areas have also been recruited in order to foster long-term sustainability of objectives. Staff returned under UoA1 thus comprise a dynamic research core that has been transformed from the previous assessment.



Research strengths returned in UoA1 include **cancer, cardiovascular diseases, inflammatory/immune diseases and infection.** These programmes are accommodated within the three largest Institutes in MVLS, namely the Institute of Cancer Sciences (ICS) (159 staff; 84 PGR students), Institute of Cardiovascular and Medical Sciences (ICAMS) (192 staff; 132 PGR students) and Institute of Infection, Immunity and Inflammation (III) (350 staff, 145 PGR students). Forty per cent of the College's returned academic staff is contained within these three Institutes.
Research Institutes are linked by a collaborative environment and philosophy that facilitates cross-disciplinary scientific partnerships and support for clinical and non-clinical training programmes. This approach has fostered cross-Institute awards from major funding bodies including the:

- Medical Research Council (MRC)/University of Glasgow Centre for Virus Research
- Wellcome Trust Centre for Molecular Parasitology
- Arthritis Research UK Rheumatoid Arthritis Pathogenesis Centre of Excellence
- British Heart Foundation (BHF) Research Excellence Award
- BHF PhD training Award
- Cancer Research UK (CR-UK) Glasgow Centre
- Experimental Cancer Medicine Centre (ECMC)

Since RAE2008, investments by the University have generated increased ***vitality*** in our UoA1 return e.g., via infrastructure spend (£105 million) and the recruitment of 45 new tenured staff. Accordingly we now return an increased proportion of staff to UoA1 with enhanced research productivity and income (increased 14% overall and by 13% per FTE [ranked 3rd in UK for clinical medicine – *HESA Statistics versus Russell Group*]; £325 million over the REF period). Moreover,

we have planned for ***sustainability*** e.g., via extensive operational and mentorship support for PGT/PGR degree programmes and new fellowship schemes for ECRs. In addition, the University has developed new comprehensive expertise in polyomic and bioinformatic technologies (through the College-wide Glasgow Polyomics Facility); advanced laboratory imaging and in vivo biology and pathogenesis of disease expertise (e.g., via the BBSRC-led Integrative Mammalian Biology Initiative Award). Thus, the UoA1 environment is one of rich intellectual and technical resource, optimised to deliver basic, translational and clinical research excellence and training.

b. Research Strategy

Since 2008, the strategy and consequent activities in UoA1 have delivered an integrated research environment that provides expertise, infrastructure and resources to facilitate cross-disciplinary research and training, leading to innovation and impact. We published 6,436 articles over 5 years, increasing year on year, representing a 30% increase since 2008. Such outputs contributed excellent science that has advanced knowledge with clinical impact (key exemplars in Table).

Molecular Mechanisms of Disease	**Cancer cell metabolism, growth, survival, invasion and metastasis**: Vousden & Gottlieb, *Nature* 2013; Machesky & Anderson, *Current Biology* 2010; Norman, Sansom & Vousden, *Cell* 2009; Sansom, *Nature* 2009 **Molecular mechanisms of pulmonary/systemic hypertension**: MacLean, *Circulation* 2008; Touyz, *Circ Res* 2010; Guzik, *Circulation* 2010 **Vascular injury, endothelium, gene therapy and miRNA**: Baker, *Cell* 2008; Baker, *Circulation* 2010; Johnstone, *Nature* 2012 **Chemokine and Cytokine Biology**: McKimmie & Graham, *Blood* 2011, 2013; Kurowska-Stolarska & McInnes, *PNAS* 2011, Liew – *Nature Medicine* 2010; Nibbs, *JCI* 2012; Willison, *JCI* 2012 **Molecular Biology of Infection**: Mottram, *PNAS*, 2012; Meissner, *Nature Methods* 2013; Penades, *Nature* 2010 & *Molecular Cell* 2013; Waters, *PLoS Pathogens* 2010
Pre-clinical Development	**Next generation sequencing, modelling and precision medicine**: Biankin, Chang & Grimmond, *Nature* 2012; Holyoake & Helgason, *JCI* 2009; Jamieson, Evans, Oien & Sansom, *PNAS* 2010 **Genetics and proteomics of hypertension and stroke**: McBride, *Nature Genetics* 2013; Dominiczak, *Cell* 2013; Padmanabhan, *NEJM* 2012; Walters, *Nature Genetics* 2012
Clinical Trials	**Childhood leukaemia, prostate and ovarian cancer**: Gibson, *JCO* 2010; Jones, *NEJM* 2011; Mcneish, *NEJM* 2012 **Changing practice in cardiac failure, stroke and diabetes**: Ford, *Lancet* 2008, *Lancet* 2010, *NEJM* 2013; Sattar, *Lancet* 2009, *Lancet* 2010; McMurray, NEJM 2010, *NEJM* 2012, *JAMA* 2013; Lees, *NEJM* 2008; Berry *NEJM,* 2013 **Novel therapies for arthropathies***:* McInnes, *Lancet* 2013

We first provide evidence demonstrating that we have achieved and exceeded our 2008 objectives, and based upon this, we propose an ambitious programme for the next review period.

B1 Achievement of Strategic Aims set in RAE2008 by theme

B1.1 Cancer Research

Cancer research in Glasgow has a long-standing international reputation for excellence in basic and clinical cancer research. Strategic research priorities are addressed in the following themes:

- Cell Biology of Cancer
- Cancer Epigenetics
- Surgical and Molecular Pathology
- Experimental Haematology
- Experimental Therapeutics
- Clinical Cancer Research

The key objectives for cancer research outlined in RAE2008 were to:

1. Recruit and develop cognate groups in specific focused areas of cancer research
2. Support and expand infrastructure for translational research
3. Bring haemato-oncology into the general cancer stream with infrastructure for staff and trials

4. Enhance clinical linkages with laboratory based groups through appointment of clinically qualified staff at both senior group leader level and more junior clinical fellowships
5. Expand our major charities funding base and increase numbers of senior fellowships and clinician scientist fellowships to develop the next generation of cancer academics

Major strategic achievements fulfilling the foregoing are highlighted below:

Significant and substantial enhancements to the cancer research environment in Glasgow have been delivered through the powerful combination of investment and international recruitment, involving the University, CR-UK, Leukaemia & Lymphoma Research (LLR), and Children with Cancer. Underpinning such investment is the internationally leading CR-UK Beatson Institute for Cancer Research (BICR) (Director: **Vousden**) that delivers an outstanding programme based on understanding the regulation of cancer cell invasion and metastasis; proliferation and growth; and cancer cell metabolism, death and survival; supported by novel in vivo cancer models of disease (GEMMs – genetically-engineered mouse models) and pre-clinical imaging. Our basic cancer research efforts are embedded mainly in the BICR and are lead by senior scientists (**Adams, Anderson, Evans, Gottlieb, Insall, Leung, Machesky, Murphy, Norman, Olson, Ryan, Sansom, Tait, Vidal, Vousden, Zanivan**). [Achieving Objectives 1,5]

Delivery of the **Wolfson-Wohl Translational Cancer Research Centre** (2013) and appointment of **Biankin** (from Australia), as the Director, represents a major step towards our overall vision to support and expand infrastructure and key personnel to deliver translational research. The Wolfson-Wohl Translational Cancer Research Centre provides comprehensive multi-disciplinary approaches to translational and clinical research focused on key themes of identifying tumour vulnerabilities and are underpinned by enabling technologies that span a number of cancer types. The Centre focuses on clinically orientated organ-specific cancer research, and encompasses units for genomics, bioinformatics, proteomics, radiation biology, patient-derived xenografts and the Analytical Services Unit in support of clinical trials. Following a £25 million infrastructure investment 8 new senior researchers, and over 150 research staff and students, have moved into the new purpose-built building, strategically situated adjacent to the BICR. [Objectives 1,2]

To bring haemato-oncology into the general cancer stream with infrastructure for staff and trials, basic and translational haemato-oncology research is now located in the purpose-built **Paul O'Gorman Leukaemia Research Centre** (Director: **Holyoake**) with a focus on fundamental mechanisms of cancer stem cell biology resulting in translational work leading to clinical trials. Clinical haemato-oncology moved into the West of Scotland Cancer Centre in 2008 unifying our translational portfolio in the discipline. Through a coordinated strategy with our partners the LLR and Children with Cancer, the centre brings together 6 clinical and non-clinical research groups and 40 scientists, currently including 19 PhD students (8 clinical research fellows). **Helgason** is an ECR in haemato-oncology recently awarded a Kay Kendall Leukaemia Fund and University Leadership Fellowship. **Holyoake** and **Copland** lead clinical trials in myeloid leukaemia and bone marrow transplantation Scotland-wide. [Objectives 2,3,5]

Delivery of near-patient and clinical research has been transformed via investment that includes the **CR-UK Clinical Trials Unit** (UK Clinical Research Collaboration accredited; >£6 million), funded by CR-UK (**Jones**); the **Glasgow Experimental Cancer Medicine Centre** (**Evans;** >£2 million), funded by CR-UK and the Chief Scientist Office, Scotland; and the **Clinical Radiation Oncology** research programme. The **CR-UK Stratified Medicine Programme** (**Oien**) is co-located with the Glasgow Bio-Repository, within the recently opened regional NHS pathology department (>50 pathologists) to facilitate tissue-based cross-thematic stratified medicine and innovative research. These resources constitute the **CR-UK Glasgow Centre** (2010) whose vision is to bring together scientists and clinicians to develop the best in cancer research, drug discovery and patient care and to promote public engagement. Since 2008, we have significantly expanded our clinical staff base. At RAE2008, both **Evans** (pancreatic cancer/translational therapeutics) and **Leung** (prostate cancer) were clinically active leaders of laboratory research groups at the CR-UK BICR. **Holyoake** led laboratory and clinical research in Chronic Myeloid Leukaemia (see above). Since 2008, we have increased the number of clinically qualified senior group leaders from 3 to 10, with 3 additional clinical ECRs (see section C1) to introduce new and expanded competencies in pancreatic cancer **(Biankin, Chang)**, ovarian cancer **(Mcneish)**, neuro-oncology and radio-biology **(Chalmers),** haemato-oncology **(Copland)** and breast cancer **(MacPherson)**. We have also

adopted a rigorous process for attracting and mentoring outstanding clinical and non-clinical scientists leading to an increase in senior fellowships and clinician scientist awards (see below). [Objectives 1,4,5]

B1.2 Cardiovascular and Related Medical Sciences Research

Cardiovascular research in Glasgow is internationally renowned for its basic, translational and clinical science. Strategic research priorities are addressed in the following themes:

- Vascular Pathophysiology & Therapy
- Heart and Stroke Research
- Diabetes, Renal, Endocrinology & Metabolic Disease
- Genetics, Genomics & Systems Medicine
- Cardiovascular Regenerative Medicine
- Clinical Trials & Implementation

The key objectives for cardiovascular research in RAE2008 were to:

1. Recruit scientists to develop research in cardiovascular science that would underpin existing cross-disciplinary collaborations
2. Increase the range and scope of our interaction with industrial and pharmaceutical partners in development of novel therapeutic approaches
3. Extend the range and scope of our clinical PhD programme to develop a new cadre of academic leaders within cardiovascular medicine
4. Develop international collaborations with key international cardiovascular Institutes and thereby promote international research opportunities for early career investigators

Major strategic achievements fulfilling the foregoing are highlighted below:

Since 2008, ICAMS has significantly developed its international profile via recruitment of strong visionary leadership (**Touyz, BHF Chair,** recruited from Canada), concentrating cardiovascular expertise in one purpose built, state-of-the art centre (**BHF Glasgow Cardiovascular Research Centre**), and investing in research-specific MRI (**BHF MRI suite** and recruitment of a lead medical physicist, **Radjenovic**). In addition we have advanced recognised research strengths and eliminated barriers between basic and clinical scientists and further enhanced impact from our pre-clinical and clinical 3T MRI facility at the BHF Glasgow Cardiovascular Research Centre. We offer substantially enhanced capabilities including molecular, cellular and stem cell biology, cardiac electrophysiology, transgenic models, in vivo phenotyping, systems biology, polyomics (via Glasgow Polyomics Facility; Director **Barrett**), bioinformatics, cell to whole body imaging, experimental medicine and clinical trials expertise. Extensive cardiovascular clinical resources are provided particularly by recent integration with the **Golden Jubilee National Hospital,** one of largest cardiovascular clinical facilities in Europe (>1800 cardiothoracic surgeries/year, >4000 catheterisations/year and >3000 percutaneous coronary interventions/year) offering a diverse, abundant, patient base for translational and clinical research and cutting edge clinical trials in devices and biologics. Similarly the Blood Pressure Unit (Western Infirmary NHS) is renowned for its clinical impact on hypertension and stroke research, evidenced by exemplar impact cases returned in REF2014. Our clinical trialists have had major impact on changing clinical practice and guidelines, both nationally and internationally, especially in the fields of heart failure, atrial fibrillation, stroke and hypertension (**Ford, Lees, McMurray**). [Objectives 1,3,4]

The ICAMS has had recent substantial funding success, particularly the **BHF Research Excellence Award** (1 of 6 in the UK; £3 million) to establish a Centre of Excellence in Vascular Biomedicine. The BHF Excellence Award is multi-disciplinary in nature and brings together researchers from ICAMS (e.g., **Baker, Delles, Dominiczak, Jardine, MacLean, McMurray, Mischak, Sattar, Touyz**); III (**Graham, McInnes**), and the Institute of Molecular, Cell and Systems Biology (**Milligan**). This initiative, which will pioneer a deeper understanding of the biology of vascular dysfunction, has embedded in it, i) innovative science focusing on vascular pathobiology and cardiovascular and associated chronic diseases, ii) establishment of new infrastructure through three new core facilities (vascular phenotyping; imaging; clinical trials), and iii) creation of two new training programmes in translational research, including clinical rotations/programmes in (cardio)vascular medicine for basic PhD scientists and robust vascular science curricula for PhD clinicians. Through such programmes, a new discipline of 'translational vascular biomedical science' will evolve, critically important for the next generation of cardiovascular scientists. ICAMS was also successful in renewing its **BHF PhD programme,** which funds 4 PhD students per

annum over 5 years. Recruitment of 6 senior researchers (including **Guzik, Mercer, Radjenovic, Touyz**) will help support these initiatives. We have expanded our scientific horizons by expanding areas of research strength, particularly cardiac/vascular regenerative medicine. Our successes are evidenced through involvement in two of the three BHF UK-wide Centres of Regenerative Medicine (**Baker**, vascular regeneration; **Smith**, cardiac regeneration). [Objectives 1,3]

We have delivered on our translational research portfolio through the first in-man trial of gene therapy (**Baker**, **Berry, Oldroyd**), in vitro induced-pluripotent stem cell development of red blood cells for transfusion (**Mountford**) and the first neural stem cell treatment in stroke patients (**Muir**). Our imaging suite has been enhanced with a 3T MRI exclusively for experimental and clinical research. ICAMS researchers are leading on new multi-centre European Union (EU) grants (>£9 million) in gene therapy and vaccinology (**Baker**), vascular phenotyping (**Delles, Dominiczak**), stroke (**Lees**) and geriatrics (**Stott**), demonstrating international/European recognition in the field, and linking academic and industry constituencies. A recent European Research Council Advanced Grant has been awarded (**Baker**). New partnerships with industry at the global level (e.g. MiRagen, Novartis, Pfizer, Genkyotex) have facilitated advancement in development of new therapeutic strategies (GSK, gene/cell/miRNA-based; **Baker, Muir, Smith**) and drugs (**Baillie, MacLean, Touyz**) as well as spin out companies (Clyde Biosciences, **Smith** and Sannox Therapeutics, **Baillie**)**.** We have secured funding for the Stratified Medicine Scotland – Innovation Centre (SMS-IC: **Dominiczak**), a consortium of Scottish Universities, NHS Scotland, and industry partners that will be based at the new South Glasgow Hospital Campus. Building on this, our reputation as an international clinical trial centre has grown since 2008 and Glasgow now leads more than 15 multi-centre cardiovascular clinical trials, with our clinical trialists having global leadership (**Ford, Jardine, Lees, McMurray, Petrie, Sattar**). ICAMS also includes research-intensive associate members from the School of Medicine focusing on developmental endocrinology (**Ahmed**, recent professorial recruit), medical genetics (**Tobias**), epilepsy (**Brodie**) and inflammatory and metabolic mechanisms and foetal programming (**Nelson**). [Objectives 2,3,4]

B1.3 Inflammation, Immunology and Infection Research

Since 2008, we have coalesced all cognate researchers within one Institute (III) that pursues 'blue-sky' science and seeks to translate this to effective interventions across the range of infectious and inflammatory diseases with national and global impact. Key themes are:

- Immunology and Inflammation
- Virology
- Parasitology
- Bacteriology

The key objectives for Infection and Immunity research in RAE2008 were to:

1. Provide state-of-the-art facilities for basic biomedical research that can be rapidly translated to deliver high quality research output
2. Expand collaborations with the main users of research locally, nationally and internationally
3. Expand our industrial collaborations with a focus on the development of novel therapeutics including anti-parasite drugs, vaccines and diagnostics
4. Apply genomics and proteomics to basic/translational research and expand our growing expertise in systems biology with the further development of our metabolomics facility

Major strategic achievements fulfilling the foregoing are highlighted below:

We have delivered state of the art facilities as planned. These are contained in the purpose built **Glasgow Biomedical Research Centre** (immunology, parasitology, bacteriology), the **Henry Wellcome Centre for Comparative Medicine** and the **MRC/University Centre for Virus Research;** the latter will shortly be integrated into a state-of-the-art new build (£42 million). These facilities are, in turn, populated by substantial new technical capabilities provided via the University and externally funded investment. This includes three new fluorescent activated cell analysers, one new fluorescent activated cell sorter, a spinning disc confocal microscope, state-of-the-art Zeiss multi-photon intravital microscopy suite (designed to our specification and unique in Europe), Deltavision super fluorescent imaging and a high-content screening facility incorporating an InCell analyser. III investigators manage, and heavily utilise, the Glasgow Polyomics Facility to integrate polyomic and systems biology at the core of our activities. [Objectives 1,4]

The **University of Glasgow Centre for Immunobiology** has been established to deliver internationally competitive advances in basic immunology (evidenced in our returned papers) particularly in the fields of T cell, B cell, and dendritic cell biology (**Milling**), immune cell signalling (**Carmody, Harnett**), 4-D immune system dynamic studies (**Brewer**, **Garside**), mucosal immunology (**Milling**, **Mowat**), cytokine biology (**Liew**, **McInnes**), and chemokine biology - the latter representing one of the largest chemokine research groups in Europe (**Graham, Nibbs**). Recognition of this excellence includes 5 programme awards and a Wellcome Trust Senior Investigator Award. We have similarly delivered on translational goals. Applied immunology focussed on elucidating the pathogenesis of inflammatory arthritis has been particularly successful in attracting the **Arthritis Research UK (ARUK) Rheumatoid Arthritis Pathogenesis Centre of Excellence** (Director: **McInnes**; with the Universities of Birmingham and Newcastle), and the **ARUK Centre for Experimental Arthritis Treatment** (Director: **McInnes**; £3.5 million). Together this has been recognised in the designation of Glasgow as a **European League Against Rheumatism Centre of Excellence**. Moreover, this programme has secured funding from Pfizer and more recently, SMS-IC to pioneer stratification of Rheumatoid Arthritis treatment within the Scottish Early Arthritis cohort (**McInnes** CI; £4 million). The autoimmune neuropathy group (**Willison**) is a global leader, exemplified in consecutive Wellcome Trust Programme funding, UK leadership of the **International Guillain-Barré Outcome Study** and directorship of the European School of Neuroimmunology. Our industrial engagement has increased substantially as evidenced by enhanced pharmaceutical income (section D); e.g., partnerships with NovoNordisk (Fellowship Programme £2 million), GSK (Arthritis Collaborative Programme ~£1 million) and the advent (in 2013) of the pioneering **GLAZgo Discovery Innovation Centre** (£4 million) with Astra Zeneca to elicit novel targets in the inflammation field. [Objectives 1-4]

The **MRC/University of Glasgow Centre for Virus Research (CVR)** (**Palmarini**; £42 million) investigates virology/infectious diseases common to clinical human and veterinary medicine (9 CVR researchers are returned to UoA6). The Centre brings infection, immunology, clinical and population biology expertise together in an integrated multi-disciplinary environment. Research spans molecular and cellular biology through to the individual host and affected population, thus integrating molecular and structural virology (**Rixon**), cell biology (**Boutel, Everett, McLauchlan**), pathogenesis (**Hale, Wilson**), viral evolution (**Leitch**, **Thomson**) and epidemiology/modelling. Building on the focus in MVLS on chronic diseases, the CVR has created clinical-academic partnerships, both locally and nationally, in the study of Hepatitis C (**McLauchlan, Patel, Thomson**). Glasgow is the managing party for MRC-funded (£1.9 million) Hepatitis C Virus (HCV) Research UK, a UK consortium creating a national cohort of HCV-infected patients. This underpins STOP-HCV (funded by MRC, £4.5 million), a group of academics and industrial partners who will establish algorithms for treatment options based on disease stratification. The tissue bank of HCV Research UK is based in Glasgow, reflecting our key status in this programme. [Objectives 1,2,4]

Parasitology research is chiefly consolidated in the **Wellcome Trust Centre for Molecular Parasitology** (**WTCMP**; Director **Waters**) that provides focus on protozoan pathogens causing malaria (**Muller, Ranford-Cartwright, Waters**), human African trypanosomiasis (**Barrett, Hammerton, de Koning, Mottram, McCulloch, MacLeod**), leishmaniasis (**Mottram**) and toxoplasmosis (**Meissner, Sheiner**). WTCMP contains a strong comparative aspect, linking human and veterinary medicine. WTCMP manages the Scottish Bioscreening Facility (**Mottram**), which provides a platform for high content RNAi and compound screening. WTCMP also enjoys its own imaging centre and bioinformatics groups, the staff of both providing critical support to the member PIs. WTCMP has partnered with the Liverpool School of Tropical Medicine, University of Liverpool and the Malawi Liverpool Wellcome Research Centre to form the **Liverpool Glasgow Global Health Centre,** funded by the Wellcome Trust, that will recruit and mentor fellows to explore clinical and basic research projects. WTCMP is also the administrative centre of EVIMalaR, **The European Virtual Institute for Malaria Research** (Leader: **Waters**) which links >65 research groups in 32 Institutes in an EC-funded Network of Excellence. Industrial ties are significant in WTCMP and include liaison with GSK through the Tres Cantos (Madrid) Open Lab Foundation and Novartis Institute of Tropical Diseases in Singapore. [Objectives 1,2,4]

Glasgow leads the **Scottish Infection Research Network** (>£3 million) to engage with national groups (Policy Unit, Hospital Acquired Infection (HAI) Task Force National Advisory Group) to identify priority areas for HAI research and to develop research streams therein. On this basis we

recruited **Penades** to provide world leading bacterial genetic capabilities thus linking community, clinical and basic bacteriology in a new mucosal bacteriology theme. [Objectives 2,4]

B2 Overarching research aims and goals

The juxtaposition of essential underpinning basic science, alongside translational and clinical research in our areas of internationally recognised competitive strength, is fundamental to our research strategy. As detailed below, we will expand our translational, and reverse-translational, research efforts. We will focus on mechanisms of chronic pathologies that comprise the major threat to global health, manifest primarily in an increasing burden of cancer, cardiovascular, inflammatory and infectious diseases. Importantly, given the prevalence of such chronic diseases, related co-morbidities and 'premature' aging amongst the West of Scotland population, Glasgow offers a rich environment in which to deliver an outstanding research platform in this regard with a view to delivering transformative therapeutic interventions. Thus, we will:

A. Conduct high quality laboratory and clinical science that defines basic molecular and cellular mechanisms in normal physiology, and that informs our understanding of the development and progression of **cancer, cardiovascular, immune and infectious diseases and their co-morbidities**. We will offer increased emphasis on translatable opportunities arising from basic research excellence. Specifically, we will;
   a. Capitalise on our new integrated University structure to utilise our cross-Institute basic and clinical research base to examine commonality of pathways, processes and strategic approaches amongst chronic pathologies and related co-morbidities
   b. Conduct exploratory clinical studies and thence phase II/phase III development programmes, particularly supporting the advent of stratified medicine-based practice, with future impact on clinical care in these diseases
   c. Provide dedicated translational infrastructure (exemplified by the GLAZgo Discovery Centre, the Glasgow ECMC, CR-UK Glasgow Centre) with full capabilities for translational project development and early stage drug discovery. In addition, we will provide pump-priming support through sources including the University's Knowledge Exchange scheme and the CR-UK Glasgow Centre's Development Fund to facilitate translation of basic science discoveries
   d. Develop social science research initiatives linked to epidemiology and public health, in collaboration with the MRC/CSO Social and Public Health Sciences Unit (University unit as of July 2013; 12 researchers returned in UoA2, and 3 in UoA22) with emphasis on population biology, and biomarker discovery to enable reverse translation studies
   e. Enhance funding success through RC-UK industrial initiatives e.g. MRC Development Pathway Funding Scheme, Technology Strategy Board, ARUK New Pathway Committee
   f. Seek spin out commercial opportunities based on in-house discovery with the assistance of the University's commercialisation team

B. Deliver the foregoing via new, and enhanced existing Centres, prominent amongst which will be the MRC/University of Glasgow Centre for Virus Research, Wellcome Trust Centre for Molecular Parasitology, British Heart Foundation Research Excellence Award, Arthritis Research UK Rheumatoid Arthritis Pathogenesis Centre of Excellence, CR-UK Glasgow Centre, CR-UK BICR and the Wolfson-Wohl Translational Cancer Research Centre.

C. Enhance impact delivery through development of new partnerships with;
   a. The pharmaceutical and biotechnology industries, e.g. via the Astra Zeneca GLAZgo Discovery Centre
   b. Academic consortia and networks in the UK, the EU and globally, and including their specific industry alliances (e.g. Astra Zeneca with the ECMC Network and the National Cancer Research Network)

D. Build capacity and sustainability by capitalising on the foregoing environment to deliver outstanding PG degree and fellowship training opportunities through the Postgraduate School, with international scope and ambition.

E. Expand international networks and collaborators through EU and other (Leducq, National Institutes of Health [USA], Canadian Institute of Health Research, Foundation for Research Support of the State of São Paulo) opportunities. The latter will focus, for example, on our established strategic partnership with University of Columbia, New York through provision of funding for collaborative engagement

(http://www.gla.ac.uk/about/internationalisation/fundingopportunities/glasgow-columbiafundphdpost-doc/).

F. Build upon robust interactions with user groups, including national and international government agencies, EU, policy makers, NGOs, patient/consumer groups, and charities.

The focal areas prioritised to deliver the foregoing are described below:

- We will investigate the *regulation of cancer cell invasion and metastasis, cancer cell metabolism, growth and survival, and leukaemia stem cells*. These studies will support our translational priority on precision (stratified) medicine strategies, initially focusing on pancreatic cancer, in which we aim to be a leading international centre for research. **Biankin** and **Grimmond** are leaders in the development of early detection and novel therapeutic strategies based on molecular phenotyping and delineation and implementation of biomarkers that facilitate clinical decision-making. **Biankin** is a member of the International Cancer Genome Consortium that aims to characterise the genomic, transcriptomic and epigenomic aberrations in patients with pancreatic cancer and to extend this knowledge into a personalised model of cancer care. This model will roll out to other priority malignancies – CML (**Holyoake**), colorectal, ovarian (**Mcneish**), brain (**Chalmers**), prostate (**Leung**). The technologies developed therein will be applied across Institute themes to empower world-class molecular biology, and informatics practice, cross-College.
- Through our BHF Centre of Research Excellence (Director: **Touyz**, Deputy: **Baker**), we will focus on *vascular injury and endothelial dysfunction as root causes of chronic diseases* including heart failure, ischaemic heart disease, stroke, vascular dementia, chronic kidney disease and cardiovascular complications of diabetes and associated metabolic diseases. This will be achieved through i) molecular and cellular interrogation of vascular dysfunction, ii) deep vascular phenotyping, iii) footprinting to predict and track disease progression iv) elucidation of mechanism of premature vascular aging, and v) development of innovative strategies to promote vascular health and repair. The inflammatory nature of these conditions forges interactions between ICAMS (**Baker, Guzik, MacLean, Touyz**) and III scientists (**Graham, McInnes**). By dissecting the intrinsic disease axes at the vascular level, new mechanistic insights and approaches in predicting, diagnosing and treating cardiovascular, and cerebrovascular, disease and target-organ damage will be discovered to provide diagnostic/therapeutic platforms for individualised risk-stratification for personalised medicine.
- We will *advance our platform for translational cell therapy approaches for cardiovascular pathologies using induced pluripotent stem cell (iPS), and adult-derived stem cell, strategies ready for first-in-man studies* (**Baker, Mountford**). These initiatives will be embedded in three major awards of which we are integral partners: the Wellcome Trust/Scottish Funding Council Blood project for the creation of iPS-derived transfusions (**Mountford**); BHF Regenerative Medicine Vascular Centre Award (**Baker**) and the BHF Regenerative Medicine Cardiac Centre Award (**Smith**). Developing our research therein will secure a robust programme in the regeneration of vascular and cardiac cells. In parallel, we will develop our research portfolio of *accelerated vascular aging*, a phenomenon that underlies many chronic cardiovascular diseases. This is an expanding area of research and will become a major theme in ICAMS. It will link into the aging programme already well established in the Institute of Biodiversity, Animal Health and Comparative Medicine (UoA5) and as such provide new collaborative opportunities between cardiovascular researchers and University zoologists and developmental biologists. In a further integrative approach, we will develop a new research theme of 'cardiovascular-oncology' as described in section B4.
- We will focus on the *analysis of cellular migration in physiological and pathological contexts to capitalise on our expertise in chemokine/cytokine biology and advanced in vivo imaging*. We will shortly create a super-resolution imaging capability (including ELYRA) to complement these studies. These capabilities will be applied to core immunology and to cancer and vascular models as required. In parallel, we will expand our cellular and molecular analyses of the activation state and ontogeny of adaptive and innate immune lineages, and the signalling pathways that support the same, via strategic recruitment, initially via replacement of the Gardiner Chair of Immunology in 2015. Our translational focus will be primarily on inflammatory arthritis (via the ARUK Centre; **McInnes**) and inflammatory neuropathy (**Willison**).
- Infection themes will focus on *basic microbial molecular and cellular biology, ontogeny and host interaction, extending through to population biology*. It will assume global translational significance via the WTCMP translational programme with the Liverpool Glasgow Global Health

Centre, and by long established interactions throughout sub-Saharan Africa. Such interactions will be used to build non-communicable diseases programmes reflecting current World Health Organisation imperatives in the region. The MRC Centre for Virus Research will form the focus for virology in this review period, but currently offers clinical translation to HCV Research UK via the clinical recruitment of **Thomson**. Finally, building on recent ambitious recruitment (**Penades**) we will develop an internationally competitive Mucosal Bacteriology Theme, with particular emphasis on hospital-acquired infections with substantial health economic impact.

- We will extend our *core mathematical modelling and bioinformatics capability to properly embrace the utility of the Glasgow Polyomics Facility.* This will benefit our basic research and also provide leadership in the development and analysis of national clinical cohorts (e.g. Scottish Early Arthritis Cohort, Stratifying RA Management in the UK; Early Arthritis in the UK; Glasgow Blood Pressure Clinic Database; Generation Scotland Scottish Family Study; Scottish Care Information-Blood Pressure – a Scotland-wide collaboration to integrate hypertensive patients) that will be critical in delivering on the UK priority of stratified and precision medicine.

B3 Clinical Trials Activity across themes

The clinical academic research excellence at the University, in partnership with NHS Greater Glasgow & Clyde, provides world-leading expertise in clinical trials across the clinical areas prioritised in UoA1. Funding from the Scottish Government's Chief Scientist Office to NHS Greater Glasgow & Clyde in support of our joint clinical trials infrastructure is £6.1 million annually, and includes research nurses and research imaging support. We have invested in a new Biorepository; a 'safe haven' for health informatics research; consultant statisticians (through the Robertson Centre for Biostatistics, Director: **Ford**), Clinical Trials Pharmacy and Pharmacovigilance. Additional investment from CR-UK supports cancer-specific clinical trials through the Glasgow ECMC (£400,000 annually) and the CR-UK Glasgow Clinical Trials Unit (CTU; £900,000 annually). This resource includes support for biostatistics, pharmacovigilance, and biomarker studies infrastructure, enabling the CTU to develop and coordinate national and international studies, especially those developed through the International Rare Cancers Initiative (UK, USA, Europe). University of Glasgow clinical trials income exceeds £21.5 million annually; we have over 1000 ongoing studies (clinical trials, governance and device studies), including 400 commercially-sponsored studies. Our current portfolio includes several first-in-man clinical trials and a wide range of Phase IIa, IIb and III trials across a broad range of diseases which lie in UoA1-prioritised areas.

Glasgow hospitals are currently undergoing major restructuring, offering an unprecedented opportunity for the University to undertake clinical research at the core of the New South Glasgow Hospitals Campus (SGH). When it opens in 2015, this hospital will be one of the largest hospitals in Europe and will include maternity, paediatric and adult services on a single site. The SGH will serve 41% (2.3 million) of Scotland's population, including areas of deprivation (and hence steep relative health outcome gradients) with a high level of morbidity. The College has recently been awarded £10 million from the UK Research Partnership Investment Fund, £3.5 million from the Sackler Foundation with additional funding of £1.6 million from the Wellcome Trust and the Wolfson Foundation to create a Clinical Research Facility (CRF) - for both adult and paediatric medicine - and a state-of-the-art imaging suite, both located at the SGH site. These new facilities will be physically linked to the Stratified Medicine Scotland – Innovation Centre (SMS-IC), a £20 million investment by the Scottish Funding Council and industry, and part of a wider £50 million investment in the clinical academic campus and stratified medicine in Glasgow. This co-location of the SMS-IC and CRF will place Glasgow at the forefront of the Stratified Medicine agenda globally. As a world leading centre in proof of concept studies in chronic degenerative diseases, stratified medicine, biomarker discovery and target validation, Glasgow's infrastructure thus draws together the necessary clinical trials, core laboratory, bioinformatics and systems medicine skills to exploit the opportunities advancing precision medicine in the 21st century.

B4 Integrating UoA1 themes to foster multi- and inter-disciplinary interactions

The new integrated environment in MVLS has established many new inter-disciplinary endeavours and bolstered existing inter-disciplinary research groupings which will be further enhanced: e.g.,

- Cardiovascular researchers in ICAMS will join cancer biologists to study mechanisms of cardiovascular disease caused by modern anti-angiogenic drugs and inhibitors of related signalling pathways (**Evans**, **Touyz)** that are increasingly being used in cancer treatment.

- III integrates with ICAMS through multiple collaborative projects, specifically related to inflammation driving atherosclerosis and vascular injury (**Baker, Graham, McInnes**), and accrued vascular risk in chronic autoimmune disease (**McInnes, Sattar**). This crosstalk will be enhanced particularly through strategic recruitment of an international immuno-vascular professorial appointment (**Guzik**).
- Cancer biologists are integrated with III via shared programmes to understand the relevance of inflammation in the pathogenesis of cancer (e.g. **Graham, Nibbs, Sansom**).

Such cross-institutional interactions provide an ideal model to study chronic diseases and co-morbidities in a truly integrated multi-disciplinary and multi-pathology approach. We will establish a 'Virtual Centre' amalgamating the University's complementary research interests incorporated in our UoA1 return. This will provide a focus for regular meetings, nurturing grant applications and will develop into a powerful force for facilitating our study of chronic pathologies and co-morbidities. We propose that, once this centre is established, we will seek external funding from agencies such as MRC to support its activities and to develop training programmes in 'chronic diseases'. In particular, the range of externally funded, cross-disciplinary Centres that we have developed (see section B1) will foster this collaborative activity.

B5 Mechanisms for developing and sustaining this research portfolio and culture

Several new strategies promoting people and science will sustain our research excellence. We are investing heavily in nurturing young investigators through numerous initiatives (section C), especially effective mentoring. These initiatives promote 22 ECRs already in post, and create a rich, dynamic environment to benefit the next generation. In addition, we offer several added incentives to sustain and develop our research portfolio; e.g.

- University-funded schemes to support/supplement expensive in vivo animal studies – MVLS initiated a scheme whereby staff (particularly ECRs) can receive £10,000 to support in vivo experiments, designed to enhance the scientific content of publications resulting from ongoing research and to provide preliminary data to support substantive grant applications. MVLS has also made a significant financial contribution (£1 million) to in vivo experimentation with reduced animal tariffs (by 30%) making in vivo experimentation more attractive to external funding agencies. Similarly we will build on the outcomes from our Integrative Mammalian Biology (IMB) in vivo award, particularly our two legacy lectureships, to further enhance excellence in core in vivo skills.
- Knowledge Exchange Committee provides funds (£1 million available), and fellowships, to pump-prime and deliver projects of an inter-disciplinary nature to foster our translational goals and bring added value to the core capabilities within UoA1 – £100,000 to UoA1 in 2012-2013.
- Seminar, lectureship, and professorial inauguration programmes (8 distinct series in UoA1) run across MVLS to foster integrated thinking and innovation.
- Research income from EU for UoA1 has grown year on year with research income for 2012-13 totalling over £4 million (>100% rise since 2008) and is projected to be sustained with the initiation of the Horizon 2020 programme. The University offers a dedicated European Support Office to promote leadership and involvement for our researchers in EU initiatives.
- MVLS has created numerous pump-priming awards through its Development Fund, e.g. via the CR-UK Glasgow Centre to promote cross-disciplinary interactions. Twenty-two awards have been made since 2010 (total £250,000).

c. People, including:

I. Staffing strategy and staff development

Since RAE2008, driven by strategic research priority setting, we have recruited high-quality staff (14 professors; 24 senior lecturers; 7 lecturers) to provide leadership/excellence (Table below).

Together, these recruits provide *institutional leadership* (**Biankin, Touyz**), enhance *clinical and translational research* (**Ahmed, Chalmers, Copland, Chang, Dale, Dawson, Freel, Halsey, Keeshan, Logue, Mark, Mcneish, MacPherson, Mercer, Millar, Porter, Radjenovic, Roxburgh, Siebert, Singh, Thomson, Valerie, Wakeham, Wheadon**) and establish *dynamic new fields of basic research* of broad relevance to our strategic aims (**Adams, Brewer, Garside, Grimmond, Guzik, Hale, Kamphorst, Maffia, Meissner, Murphy, Penades, Tait, Wells, Waters, Wilson, Vidal, Zanivan**). For example, the specific recruitment of **Biankin, Carmody, Grimmond** and

Wells has allowed us to develop a new, and internationally integrated, genomics research programme operating together with the Glasgow Polyomics Facility. This is designed to enhance activities in all three research areas submitted under UoA1 with underpinning expertise and insights. This initiative is already active in supporting large scale genomic analyses in cardiovascular and cancer contexts and, in immunology, by capitalising on the unique resources available through **Carmody, Grimmond** and **Wells** in transforming our ability to interrogate myelomonocytic cell and molecular biology.

Nonclinical Professors
- Professor Peter Adams
- Professor James Brewer
- Professor Paul Garside
- Professor Sean Grimmond
- Professor Marcus Meissner
- Professor Jose Penades
- Professor Andrew Waters

Clinical Professors
- Professor Faisal Ahmed
- Professor Andrew Biankin
- Professor Anthony Chalmers
- Professor Mhairi Copland
- Professor Tomasz Guzik
- Professor Ian Mcneish
- Professor RhianTouyz

Nonclinical Senior Lecturers
- Dr Ruaidhri Carmody
- Dr Jurre Kamphorst (ECR)
- Dr Karen Keeshan
- Dr Pasquale Maffia
- Dr John Mercer
- Dr Daniel Murphy
- Dr Stephen Tait (ECR)
- Dr Christine Wells
- Dr Helen Wheadon
- Dr Marcos Vidal
- Dr Sara Zanivan (ECR)

Clinical Senior lecturers
- Dr David Chang (ECR)
- Dr Jesse Dawson
- Dr Marie Freel
- Dr Christina Halsey
- Dr Jennifer Logue
- Dr Iain MacPherson (ECR)
- Dr Patrick Mark
- Dr David Preiss (ECR)
- Dr Duncan Porter
- Dr Stefan Siebert
- Dr Emma Thomson
- Dr Nicola Valeri (ECR)

Lecturers
- Dr James Dale (ECR)
- Dr Ben Hale (ECR)
- Dr Neal Millar (ECR)
- Dr Jagtar Nijjar Singh (ECR)
- Dr Patricia Roxburgh (ECR)
- Dr Sam Wilson (ECR)
- Dr Katie Wakeham (ECR)

C1.1 Staff Support and Development, with focus on ECR

The University recognises the importance of developing our staff resources to optimise performance and productivity, and to ensure fulfilment of individual ambitions. New and existing UoA1 staff have benefited from a comprehensive University staff development programme, and from specific initiatives that focus on the particular discipline-specific requirements. Our staff development programme aims to:
- Enable the development of world-class strategic leadership and management skills for all staff in 'managerial' positions to develop research excellence and creativity across UoA1
- Facilitate inter-disciplinary research approaches especially by bringing together basic and clinical, and University and NHS research staff
- Support and nurture ECRs
- Promote structured peer-to-peer/manager-to-staff learning and performance development
- Support staff development through defining strategically aligned performance expectations

The following have contributed to the realisation of these aims:

(i) Implementation of the Concordat to Support the Career Development of Researchers:

Commensurate with the requirements of the Concordat, Staff Development Services provide a broad range of generic training options as an 'early career researcher portfolio' (http://www.gla.ac.uk/services/humanresource/staffdevelopment/). These include building effective research collaborations, winning research income, Business Administrative and Planning Skills (e.g. project management skills, running effective meetings) and Internationalisation (e.g. Developing an International Professional Network, International Academic Collaborations: An Introduction).

(ii) Mentoring for early career researchers: In addition to the generic training above, the UoA1 research community has developed support structures for ECRs. Specifically, to support research focus, maximise grant income and optimise publication output, we operate an MVLS *mentorship programme* wherein experienced senior staff are appointed as mentors to ECRs up to Senior Lecturer level. In addition, a *mentorship forum* has been established which serves as a regular meeting point for ECRs. This forum is open to career development fellows/senior postdocs but is also valued by PhD students integrated therein. It has provided an invaluable forum for discussion of a range of employment and career issues of particular relevance to this staff grouping.

(iii) University of Glasgow funded initiatives: The following have also been important in support of ECRs within UoA1:

a) Lord Kelvin Adam Smith Fellowships: In 2012, the University invested over £7 million to support the appointment of Lord Kelvin Adam Smith Fellows. The aim of this was to attract young researchers of exceptional quality to the University who will, in turn, secure grant funding thereby ensuring sustainability. Five of these fellows were appointed to UoA1 disciplines, namely **Barr, Braconi, Johnstone, McKimmie** and **Robson**. These fellowships provide salary funding (3 years) and £50,000 in additional research support. The appointees are mentored as described above and can track to academic staff status, subject to performance. Although early, these appointments have already brought novel B cell and NK cell biology to the immunology area, and have supported the development of an important strategic link between chemokine biology, viral arthropathies and the MRC Centre for Virus Research.

b) Leadership Fellowships: Similarly, the University invested £3.75 million in Leadership Fellowships to attract and retain high calibre young researchers with externally funded fellowships. Financial packages of up to £125,000 over 5 years supported 30 Leadership Fellows across disciplines. Six such fellows (**Bradshaw, Cordero, Helgason, Miller, Montezano, Sheiner**) have joined UoA1 disciplines delivering high quality and productivity. Importantly, each of these appointees is returned in this submission, testament that strategic placement of these fellows has already fostered novel collaboration, e.g. **Miller** operating between III and the metabolic group in ICAMS; and **Helgason** (located in the Wolfson-Wohl Translational Cancer Research Centre) strengthening the links between the Paul O'Gorman Leukaemia Research Laboratories and the autophagy theme researchers at the BICR.

Additional externally funded initiatives support ECRs through the following:

- The BHF Centre of Research Excellence award will create innovative training programmes focusing on vascular biomedicine for clinical and non-clinical fellows. Twenty outstanding trainees will be funded through these new programmes, which will link to international centres of excellence in vascular research. Sustainability of such programmes will be assured by new funding attracted through the success of these initiatives and their progeny. In addition, cross-institutional networking to nurture our ECRs has been established through a joint ICAMS/III seminar series, as well as through Young Investigator Networks operating in both ICAMS and III (~30-50 attendees bi-monthly for each).
- The University plays a prominent role in broader clinical academic capacity training via the Scottish MRC Clinical Pharmacology and Pathology Training Programme (Director: **McInnes**), Wellcome Trust Scottish Translational Medicine and Therapeutics Initiative (Deputy Director: **McInnes**) – together training ~35 clinician-scientists.

This approach has been highly successful, attracting 130 externally funded fellowships in the review period with a value of £23.7 million.

(iv) Travel scholarships for staff and research students: UoA1 benefits from a variety of University travel scholarships for staff and students, e.g., the John Robertson Bequest that supports 'original research' for pump-priming, travel and blue sky ideas (~£20,000/year); the International Partnership Development Fun (£50,000/year); and Mac Robertson Scholarships to provide funding for postgraduate research students to undertake a course of study at a centre of advanced study. Other University-specific travel scholarships are aimed at fostering collaborations with target institutions, such as Columbia University – the University has committed £40,000 for Columbia travel awards. Investment by the University to support student exchanges to China (Sun-Yat Sen University) will facilitate collaborative research primarily in UoA1 subject areas and also educate our young scientists about research, and clinical priorities, in China.

(v) Other University-wide support for early career researchers: The University provides the following additional support for ECR development:

- Links with institutional monitoring and audit appraisals ensure that all staff benefit from their annual review; this further ensures effective induction of ECRs.
- The University's Code of Practice for the Management of Research Staff was launched at the 2012 Research Staff Conference. It outlines responsibilities of researchers, PIs and Schools/Institutes, or mentors, and is available on the Research Staff and Principal Investigator web portals, as well as being provided to new staff at inductions and to existing staff through committees and research staff/PI training programmes.
- The University of Glasgow Crucible Programme for ECRs aims to promote cross-disciplinary collaboration. The good practice from this programme within MVLS is 'championed' by **Walters**.
- Implementation of the Researcher Development Framework, including piloting the Vitae online planner tool.
- Development of tailored Performance and Development Review (see below) process for ECRs.
- Provision of mentoring, online resources, training workshops and mock interviews for research staff applying for internal or external fellowships and major grants.

(vi) EU HR Excellence in Research Award: The University was 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. To qualify, the University provided processes aligned to the principles of the European Charter for Researchers and the Code of Conduct for their recruitment. In the UK this process incorporates both the 'QAA Code of Practice for Research Degree Programmes' and the 'Concordat to Support the Career Development of Researchers'.

C1.2 Performance and Development Review

All research staff are reviewed on an annual basis, assessed against both published performance criteria (research outputs, research funding, postgraduate supervision, knowledge exchange [including impact], learning and teaching, leadership and management, esteem) and individual objectives as agreed with their line manager. Output from this process informs applications for internal promotion and the formulation of a Personal Development Plan for the coming year.

Developing clinical researchers and their activities. We have developed robust initiatives for our young clinical academic researchers through the Clinical Academic Training Advisory Committee (CATAC), which acts as the interface between the Postgraduate Deanery of NHS Education for Scotland and the Graduate School of MVLS. The objective of CATAC is to oversee the academic training of clinical trainees in lecturer or research fellow positions. CATAC also oversees the Academic Foundation Year programme and academic core training (the Glasgow Academic Training Environment) that provide academic mentorship to young doctors over the first 4 years of their postgraduate training. Furthermore, joint supervision of Clinical Research Fellows by clinical and basic scientists has proven to be an effective mechanism to encourage interaction and collaboration, and to develop the next generation of clinician-scientists.

C1.3 Support of Equality and Diversity

The University is committed to achieving equality and diversity objectives, fostering an educational and research environment that is inclusive, and embraces diversity by valuing and respecting the perspectives and contributions of all our staff and students. Furthermore, the University has identified the need to attract and retain internationally recognised academics, nurture the development of our talented ECRs, cultivate the research leaders of the future, establish a rich research environment and to foster and support a diverse research student population. University HR policies and procedures are designed and continually reviewed to develop and support high achieving academics in relation to achieving its strategic ambitions outlined in **Glasgow 2020: A Global Vision**. These focus upon maximising performance, career development and succession planning for all research and teaching staff. At professorial level, performance assessed as outstanding normally ensures a performance-related pay award, which, if repeated in subsequent years is consolidated. More generally, professorial pay zones are assigned against published performance metrics, assessed by an externally moderated peer-review panel. Pay and reward transparency largely corrected previous gender, and other, inequalities and our pay equality is amongst the best in the sector. This was borne out following the implementation of professorial zoning in spring 2012, with significant improvement in the pay relativities, and zone distribution, of female professors in relation to pre- and post-zoning outcomes in percentage terms. This impacted

positively upon 36% of the female professorial population by effectively recognising and rewarding their profiles at a higher zone, and salary level, consistent with the zone.

The University has introduced a number of equality and diversity initiatives. A **Dignity at Work Policy** was introduced and a network of volunteer harassment advisers to support any staff and students who feel they are being bullied or harassed. A number of senior management are **Equality Champions** for the equality strands: age, disability, gender, race, religion and belief, and sexual orientation. In addition, the University has a **Disability Service for Staff and Students** and a staff network for **LGBT Staff**. We also provide **Equality & Diversity Training** via two online training courses: 'Equality and Diversity Essentials' outlines the key legislation in relation to the Equality Act 2010, the protected characteristics and types of discrimination and harassment. All staff are encouraged to participate and it was mandatory for staff involved in REF selection processes. 'Managing Diversity' looks at the benefits of managing diverse teams, and how to challenge unacceptable behaviour. The University has embedded equality training into all management and leadership courses provided by the University. **Athena Swan Bronze Award:** The Athena Swan Charter recognises commitment to advancing women's careers in science, technology, engineering, maths and medicine (STEMM) in higher education. We joined the Athena Swan Charter in August 2011. The University action plan (2012-2015) identifies key steps being taken to advance women in the STEMM disciplines but also to advancing female academics employed in non-STEMM disciplines. The University has also 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. The University has funded one FTE to support MVLS applications in support of the Athena Swan action plan, with additional support available from the University Senior Management Group to develop individual applications. Individual Institutes (e.g. ICAMS) have put into place an Athena Swan Bronze Award application (Nov 2013). Within the University UoA1 return, female researchers play prominent roles. For example the director of ICAMS (**Touyz**), the director of the CR-UK Beatson Institute (**Vousden**), the director of the Paul O'Gorman Leukaemia Research Centre (**Holyoake**) and the Head of College (**Dominiczak**) are all women. As such, women are prominently represented at the highest leadership levels within UoA1.

c. II. Research students

Basic, translational and clinical research within UoA1 returns all benefit from a variety of training programmes funded by national and international agencies. All postgraduate research (PGR) is administered via a unified College Graduate School. This provides a PGR and postgraduate taught (PGT) learning environment, delivering College level events, training, skills, conferences, community outreach, Knowledge Transfer, seminars, workshops and publications; which has a sense of its own identity and purpose. Strategic decisions about investment and scholarships, coordination of intra-College initiatives, regulatory matters and admissions are undertaken at this level. The Dean of Graduate Studies (**Mottram**) has primary responsibility for all academic matters in relation to postgraduate (PG) studies and works closely with others in the Graduate School structure to ensure its effective operation. Sophisticated pastoral and mentorship schemes operate to ensure high quality student experience. MVLS currently trains 650 PhD students. Research within our UoA1 return benefits from many prestigious doctoral funding programmes particularly:

- BBSRC (Doctoral Training Partnership)
- MRC (Doctoral Training Grant)
- CR-UK Centre Clinical and Non-clinical Training Programme
- BHF PhD programme
- In vivo Integrative Mammalian Biology training programme – BBSRC
- Wellcome Trust non-clinical PhD programme
- Marie Curie ITN ADVANCE programme
- Wellcome Trust STMTI for Clinical Training
- MRC-SCP3 Programme
- Oliver Bird PhD Studentship Programme
- Arthritis Research UK Centre of Excellence in Rheumatoid Arthritis Pathogenesis
- GLAZgo Discovery Centre PhD Studentship Programme

Overall these programmes provide 55 studentship opportunities per annum. We have increased

our PGR population by more than 164 students (69%) since RAE2008 with 1.94 PGR students per academic FTE, which compares favourably with the Russell Group median of 1.48. Internal support programmes include the University of Glasgow Kelvin Smith Studentship scheme that particularly fosters cross-disciplinary research. In addition to excellent mentorship and career development, our growing student cohort enjoys access to state-of-the-art technologies. The International Student Barometer (2011 and 2012) ranked Glasgow 1st in the UK for satisfaction in a worldwide survey. In the 2011 'Postgraduate Research Experience Survey', 5% more students from the University, compared to the Russell Group average, considered that the environment fully met their expectations – 99% reported that appropriate structures were in place to ensure effective supervision of PG research and to support successful and timely completion of studies. Thus we offer a rich and extremely high quality environment for PG training.

PGR Development Programme: Building on the successes of the Roberts funding, the University now invests £300,000 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 Research Council UK Joint Skills Statement (and latterly the Researcher Development Framework) while also enabling our students to engage nationally and internationally with their peers. Training packages developed at the University of Glasgow have been shortlisted for Times Higher Education awards (Making an Impact with your PhD, 2010) and the University collaborated in a Scotland-wide programme, focused on training for knowledge exchange, which received a THE award in 2010.

d. Income, infrastructure and facilities

D1 Income

Commensurate with our strategic research priorities, we seek support from relevant Research Councils, UK charities, overseas development funds and cognate industrial partners. Income from various funder sources over time is detailed below and our proportional income per target agency is depicted in the pie-chart (right). Our strategy in terms of funding income is three-fold. First we seek to enhance research income per FTE by targeted support for grant preparation, with rigorous mentoring and pre-submission review, particularly for ECRs. Second we seek a balanced portfolio of funding sources and monitor our submissions accordingly (Table 1). Third we bring cognate expertise together whenever possible to optimise the likelihood of success – in consequence we evidence high quality collaborative funding cross-College (Table 2).

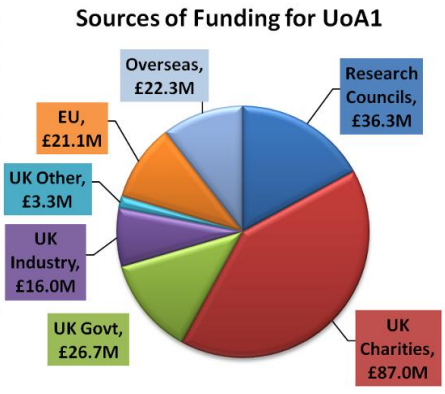


Table 1: *Balance of research awards across UoA1 themes*

Funder Type	FY 2008 *(01/01 -- 31/07)*	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013		*%change 2009-2013*
Research Councils	£2,593,142	£5,623,150	£7,385,441	£7,731,321	£5,642,130	£7,279,132	**£36,254,317**	***129%***
UK Charities	£11,244,644	£18,643,597	£12,255,286	£15,519,673	£9,511,855	£19,870,170	**£87,045,225**	***107%***
UK Govt	£3,239,308	£6,397,181	£4,371,214	£3,888,014	£4,510,336	£4,317,331	**£26,723,384**	***67%***
UK Industry	£3,122,995	£2,814,585	£1,364,100	£4,898,404	£1,691,757	£6,074,252	**£19,966,092**	***216%***
UK Other	£14,600	£943,944	£1,075,901	£529,598	£53,389	£650,923	**£3,268,355**	***69%***
EU	£1,294,976	£2,327,055	£3,705,468	£1,137,811	£9,844,319	£2,831,474	**£21,141,103**	***122%***
Overseas	£990,920	£2,791,479	£3,798,426	£6,934,774	£3,770,130	£4,047,335	**£22,333,063**	***145%***
TOTAL	**£22,500,585**	**£39,540,990**	**£33,955,835**	**£40,639,595**	**£35,023,915**	**£45,070,617**	**£216,731,538**	***114%***

This performance represents a 14% rise over the review period, with improved returns in Research Council, industry (>100% increase) and overseas funding sources. We received 22 individual

research awards over £1 million, across a range of investigators reflecting excellence across the clinical and scientific subject spectrum returned in UoA1. Moreover our income per FTE has risen significantly (by 13%) since 2009; HESA ranked Glasgow as 3rd in the UK for Clinical Medicine. Thus we have secured broad-based, highly competitive funding to sustain our research ambitions.

Table 2: *Exemplars of cross cutting research projects*

Project Title	Funder	Duration	Investigators	Total Value
The Multi-Corder: Poly-Sensor Technology	EPSRC	2013-2017	Prof MICHAEL P BARRETT (IIIs, MVLS)	£3,403,307
			Prof LEROY CRONIN (Chemistry, Sci & Eng)	
			Prof DAVID CUMMING (Engineering, Sci & Eng)	
Listening to the Microworld	EPSRC	2008-2012	DR ANDREW PITT (MVLS)	£1,251,552
			Prof JONATHAN M COOPER (Chemistry, Sci & Eng)	
			Prof MILES PADGETT (Physics & Astronomy, Sci & Eng)	
Key survival pathways in chronic myeloid leukaemic (CML) stem cells and novel approaches to their eradication	Cancer Research UK	2010-2015	Prof TESSA HOLYOAKE (ICS, MVLS)	£1,064,011
			MS TANIA GALABOVA (Computing Science, Sci & Eng)	
Scottish Health Informatics Programme (SHIP)	Wellcome Trust	2009-2014	DR ROBERT S LINDSAY (ICAMS, MVLS)	£660,241
			Prof ANDREW H BRIGGS (IHW, MVLS)	
			Prof IAN FORD (IHW, MVLS)	
			DR RICHARD O SINNOTT (e-Science Centre, Central Services)	
Scottish Universities Life Sciences Alliance (SULSA)- Cell Biology	SFC	2008-2015	Prof GODFREY L SMITH (ICAMS, MVLS)	£600,000
			Prof JONATHAN M COOPER (Chemistry, Sci & Eng)	
Electrophysiology Chip on a Microfluidic Platform	BBSRC	2011-2014	Prof GODFREY L SMITH (ICAMS, MVLS)	£489,279
			Prof JONATHAN M COOPER (Chemistry, Sci & Eng)	
National e-Science Centre Research Platform (NRP)	EPSRC	2008-2013	Prof IAN FORD (IHW, MVLS)	£353,970
			DR RICHARD O SINNOTT (e-Science Centre, Central Services)	

D2 Infrastructure and Facilities

Since 2008 the University, with support from various external funding agencies, has embarked on an ongoing, ambitious, programme of improvements (£105 million) in infrastructure and technical resources to support MVLS. UoA1 has benefitted from this generous structural investment in particular from the following:

a) Infrastructure:

- In 2008 the Paul O'Gorman Leukaemia Research Centre (£2.8 million) was formally opened by Dr Richard Rockefeller to provide purpose-built translational research facilities for stem cell focused haemato-oncology.
- In 2008 the CR-UK BICR moved into a new, purpose-built, research building. This building provides a focus for cancer research excellence in the city and houses a range of cutting edge technologies, particularly in pre-clinical imaging and GEMMs, available for use not only by CR-UK Beatson Institute staff but also cross-College.
- In 2012 the CR-UK BICR (£15.1 million) opened a new 'clean animal facility' that allows for animals to be bred in the highest quality facilities available anywhere in the UK. All animals within this facility have been rederived ensuring their cleanliness and pathogen-free status. This facility has been made available to many of the researchers returned under UoA1 and has represented a significant boost to our in vivo research efforts.
- In 2013 the Wolfson-Wohl Translational Cancer Research Centre (£24.6 million) was opened. This building is directly linked to the BICR with which it will share resources, seminar programmes and expertise. The Glasgow Polyomics Facility is housed in this building to maximise connectivity.
- Building commenced in 2012 on the new Centre for Virus Research building (£20 million) which is substantially funded by the MRC and which is due to open in June 2014. This will allow the integration of all virology research in Glasgow and will unite researchers from the previous MRC Unit with University colleagues.
- In 2015 the new South Glasgow Hospital will be completed and will represent an unparalleled focus for clinical and translational research in Glasgow. This will include the new CRF (described in B3 above), state-of-the art imaging suite, including a 7TMRI, with total academic investment of £50 million in place. It will further integrate the SMS-Innovation Centre (above).

b) Enhanced and integrated technical resources:

Paralleling the infrastructural developments, substantial enhancements to the technical resources available to staff returned under UoA1 have progressed. Many of these developments have been facilitated by the new College structure and integrated funding base.

- The Scottish Universities Life Sciences Alliance (SULSA) provided high levels of investment to support expensive key core technologies and staff (£0.5 million). In particular SULSA has provided funding for a high content screening facility and has facilitated drug screening and development. The Glasgow Polyomics Facility has allowed us to integrate, and expand, the polyomic activities within the University. This facility provides a full range of analysis options including proteomics, metabolomics and transcriptomics, and has embedded bioinformatic capabilities. In addition, this facility runs training courses for Masters and PhD students providing a significant boost to our teaching portfolio.
- Through the auspices of Glasgow Biomedicine, our overarching Clinical Trial Board, the University also provides access to a substantial tissue repository which houses a wide range of archival tissue samples available for ethically approved projects. In addition, the University funds a Research Governance Officer (based in Glasgow Biomedicine) who is involved in advising on all issues relating to clinical/translational research carried out in the University.
- A recent important development has been the establishment of Innovative Medicines Initiative (IMI) funding to support the creation of an IMI European Lead Factory situated at Newhouse (10 miles from Glasgow). This funding will provide access (following project review) to expertise, and molecular libraries, appropriate for drug discovery and development.

D3 Research Governance Structure

As a research-led institution, the University of Glasgow is committed to providing an environment that ensures our research is conducted to the highest quality standards. The University's Research Strategy and Innovation Office has responsibility for University policies and strategies relating to research, including those that govern good research practice at the University. The University's Research Governance Team, which is managed by MVLS, has overall responsibility for ensuring the University is compliant with all relevant legislation relating to research involving humans and human tissue. The University's Research Governance Team work in partnership with NHS Greater Glasgow & Clyde, through 'Glasgow Biomedicine', provides a one-stop-shop to support clinical academics carrying out clinical trials, Research Governance Framework studies and research involving human tissue.

e. Collaboration and contribution to the discipline or research base

UoA1 staff delivers broad participation, and receive substantial recognition, across the academic international community evidenced as follows:

(i) Funding Committees: Staff returned under UoA1 serve on the boards and panels for major national and international grant funding agencies such as the Wellcome Trust, MRC, BHF, BBSRC, CR-UK, LLR, National Institutes of Health (USA), Canadian Institutes of Health Research, Juvenile Diabetes Research Foundation and Union for International Cancer Control. In addition our staff have key leadership roles in these agencies: **Baker**, Chair of the Science Funding Committee for Medical Research Scotland; **Dominiczak**, Vice-Chair Leducq Foundation Scientific Committee; **McInnes**, Chair of the ARUK New Agents Committee, Chair of the European Rheumatology Research Foundation, Vice-Chair of the ARUK Research Committee and Deputy Chair of MRC Clinical Training Panel; **MacLean**, Vice-Chair of BBSRC Committee A and Vice-Chair of BBSRC International Council of Associations for Science Education Committee; **Touyz**, Chair of the Canadian Institute of Health Research, Cardiovascular System eCommittee and Chair of the Heart and Stroke Foundation of Canada Committee IVb; **Chalmers**, Vice-Chair CR-UK Clinical Trials Awards and Advisory Committee.

(ii) Fellowships and relevant awards: The excellence of our researchers is evidenced by numerous honours, awards and fellowships across disciplines. In summary, these include:

- 2 Fellows of the Royal Society (**Liew, Vousden**), 22 Fellows of the Royal Society of Edinburgh (**Baker, Barrett, Dominiczak, Ford, Fraser, Garside, Graham, Holyoake, Liew, McColl, MacFarlane, McInnes, MacLean, McMurray, Mottram, Neil, Sansom, Sattar, Touyz, Waters, Willison, Vousden**) and 6 Fellows of the Academy of Medical Sciences (**Dominiczak, Holyoake, Liew, McColl, McInnes, Vousden**). **Dominiczak** is Vice President Life Sciences of the Royal Society of Edinburgh and Council member of the Academy of Medical Sciences.

UoA1 returned researchers have received honours from CR-UK Future Leaders in Cancer Research (**Sansom**); The Margaret Vogt Lecture, SALK, San Diego (**Vousden**); Cancer Institute NSW Wildfire Award, Landon Foundation-American Association for Cancer Research,

INNOVATOR Award for International Collaboration in Cancer Research, Hirshberg Award for Pancreatic Cancer, American Pancreatic Association (**Biankin**); Tenovus Medal (**Ryan**) and the Scottish Health Award in Cancer (**Holyoake**), Outstanding achievement award from the European Society of Cardiology (**Baker**); Vincenzo Panagia Distinguished Lecture Award, Institute of Cardiovascular Sciences Award, Distinguished Scientist Award Hypertension Canada, Robert M. Berne Distinguished Lecturer of the American Physiological Society (**Touyz**); The Graham Lecture and Medal, The Royal Philosophical Society of Glasgow, Sackler Fellowship and Lecture, Tel Aviv, William Harvey Outstanding Contribution to Science Medal and Lecture (**Dominiczak**); Royal Society Leverhulme Trust Senior Research Fellowship, British Pharmacological Society AstraZeneca Prize for Women in Pharmacology, MBE (Services to Science), Estelle Grover Award and prize lecturer, American Thoracic Society, Prize lecture British Pharmacological Society-Astrazeneca prize for women in pharmacology (**MacLean**); Droitwich Lecture British Society of Rheumatology, Paul J Bilka Visiting Professorship Mayo Clinic, Gerald Weissman Lecture in Rheumatology New York, Cochrane Annual Lecture, UAB, USA (**McInnes**).

(iii) Journal Editorships: Staff returned under UoA1 play prominent roles in the editorship of national and international journals as follows:

- Annals of Rheumatic Diseases – Associate Editor (**McInnes**)
- British Journal of Cancer – Editor, Clinical Section (**Evans**)
- Clinical Science – Editor-in-Chief (**Touyz**)
- Clinical Trials – Deputy Editor (**Ford**)
- European Journal of Immunology – Editor (**Liew** -2011); Editorial Exec Committee (**McInnes**)
- Hypertension, AHA – Editor-in-Chief (**Dominiczak**), Deputy Editor (**Touyz**)
- Molecular and Cellular Biology – Senior Editor (**Gottlieb**)
- Mucosal Immunology – Associate Editors (**Mowat, Garside**)
- New England Medical Journal – Editor (**McMurray**)
- Oncogene – Deputy Editor (**Vousden**)
- PLoS Genetics – Associate Editor (**Wells**)
- PlosMedicine (**Ford**)

(iv) International collaborations: Researchers in UoA1 have strong links and active collaborations with many international research groups. This is evidenced by productivity through co-authored publications (provided in submitted papers), student exchanges and sustainability through shared renewable research grants, and particularly by European consortia awards in which we lead or participate. We also engage in strategic collaborations with partner academic organisations. Key exemplars include Columbia University, New York, USA (**Dominiczak**); Weizmann Institute of Science, Israel (**Dominiczak**), Sun-Yat Sen University, China (**Walters**); University Sao Paulo, Brazil (**Liew, Touyz**); Baker Research Institute, Melbourne, Australia (**Touyz**); Rheumatology AMC, Amsterdam, Netherlands (**McInnes**); UT Southwestern, Dallas, USA (**Baker**); University of Sydney (**Biankin**).