Institution: Cardiff University

Unit of Assessment: UoA1

a. Overview

Cardiff University's (CU) School of Medicine (SoM) UoA1 return comprises researchers from the Institutes of Infection and Immunity (I&I) and Cancer and Genetics (ICG). These are co-located in adjacent research buildings on the University Hospital of Wales (UHW) campus, facilitating clinical interactions with the NHS and a patient population that extends across Wales.

The Unit's research (headcount: 76 (72 Cat A and 4 Cat C)) spans the translational spectrum from molecular and cellular biology to clinical trials and the evaluation of innovations in practice. This complements and links with the pharmaceutical and diagnostic sectors in preclinical research and clinical trials. Working with commercial partners has led to development of novel biomarkers, targets and drugs. Links to the commercial sector in Wales and internationally have achieved licensing and spinout successes creating revenue of £1.78M in the assessment period (see Section d). During the REF period, the Unit won £83.7M in grant and infrastructure funding (based on external income spend/yr), and current active grants are worth £59M. The Unit published more than 2100 articles in peer reviewed journals and supervised 105 PhD and 46 MD students to completion with a further 160 currently registered.

Collaborations between the institutes are extensive (through joint grant income and key appointments, and shared technologies and equipment (Central Biotechnology, CBS). Research is sub-divided into focused themes that are described in Section b).

In the latter stages of the REF period, under the leadership of the new Vice Chancellor Professor Colin Riordan, Cardiff University was re-structured into 3 colleges each led by a Pro-Vice Chancellor. Research carried out in UoA1 is now within the College of Biomedical and Life Sciences

The University is committed to providing major investment in the region of £200-250M, in staff, PGR students and capital development to support the delivery of research excellence and impact as outlined in our new 5-year research strategy.

b. Research strategy

During the assessment period: The overarching research strategy for the Unit was to exploit existing strengths in basic research to underpin our translational research, improve patient outcomes and create economic value for Wales and the UK. Key aims were to:

(i) Improve research quality and capacity
(ii) Enhance the translational potential of our research
(iii) Enhance our clinical research portfolio
(iv) Raise our international profile.

These were achieved through the following mechanisms:

- **A New School and University Structure:** The School of Medicine (SoM) was reorganised in 2011 to create five research Institutes, two of which constitute our return in UoA1. In 2012 the university was restructured, bringing all health and biomedicine schools into a single College of Biomedical & Life Sciences, specifically aimed at increasing research focus and performance.

- **New Research Buildings and Co-localisation of Themed Research:** Members of I&I were relocated to occupy all five floors of the **Henry Wellcome Building**, a >£18M flagship research facility opened in 2003. ICG members occupy the adjacent **Cancer Genetics Building** (£5M), opened in 2010. The two Institutes share meeting space and social facilities in the Henry Wellcome Building. Adjacent, a new **Positron Emission Tomography (PET) Research Centre** (in operation from 2010; >£15M from CU and Welsh Government), provides both patient and small animal imaging and includes an on-site cyclotron for novel ligand production. The **Hadyn Ellis Building**, a £30M new build on the University's Maindy Road campus was opened in August 2013, and houses the **European Cancer Stem Cell Research Institute**, initiated in 2010 with £3M core funding from CU comprising Cancer researchers from the Unit and from the School of Biosciences. This interdisciplinary centre focuses on the roles of stem cells in cancer development and metastasis.

- **Expansion and Consolidation of Cancer and Genetic Research:** ICG brought together

expertise in the characterisation of somatic and inherited genetic variation in cancers, functional work in cell and preclinical cancer models and clinical trials to build a platform for stratified medicine in cancer research and for therapeutic research in inherited neoplastic disorders. The Unit's PIs won significant funds from Welsh Government and major cancer charities that strengthened the infrastructure for this work: including the **Cancer Genetics Biomedical Research Unit** (National Institute of Social Care and Health Research (NISCHR) funded in 2012, £1.65M); the **Cardiff Cancer Research UK Centre** (£2.1M from CR-UK, 2009); the **Experimental Cancer Medicine Centre** (Welsh Government and CR-UK funded, >£5M, 2011); the **Centre of Excellence for Leukaemia and Lymphoma Research**; the **European Cancer Stem Cell Research Institute** (above) and **Wales Gene Park** (NISCHR, £6M in the period). The **Cardiff Cancer Collaborative** provides an umbrella organisation for cancer research and ensures a seamless strategy across the University and NHS.

- **Expansion of Research in Infection and Immunity:** Unit staff led a successful bid to the Wellcome Institutional Strategic Support Fund (ISSF) and NISCHR/Welsh Government (total £4.5M, 2011) to develop a **Centre for Immunodiagnostics and Immunotherapeutics** supporting projects, junior fellowships, equipment and mobility. This award has been used to lay foundations for a Wellcome Strategic Award bid in 2014. The **Cardiff Regional Experimental Arthritis Treatment and Evaluation Centre** (CREATE, AR-UK £0.4M), was established in 2011, and supports clinical trial activity and research with the pharmaceutical sector (Ferring Pharmaceuticals, Roche, NovImmune SA).
- **Recruitment in Key areas to Facilitate Translational Research:** RAE2008 demonstrated key strengths in basic research across the Unit, but a lack of clinical researchers to drive translation. Strategic Professorial appointments were made in **Dermatology** (Skin Immunology and Cancer); **Rheumatology** (clinical trials in Rheumatologic Diseases); **Diabetes and Endocrinology** (biology of Type I Diabetes - Mouse to Man) and **Cancer** (appointments in Urological Surgery; Breast; Early Phase trials; Haematological Malignancy). A Clinical Professor was appointed jointly between the Local Health Board and University as R&D Director, aligning both R&D offices and simplifying clinical research governance and management.
- **Increased Clinical Trials Activity:** Unit researchers led increased numbers of UKCRN portfolio registered high quality clinical trials and mechanism of action studies in patients during the assessment period (there are currently >48 studies in relevant topics on the NISCHR Clinical Research Portfolio). These utilised our UK Clinical Research Collaboration (CRC) registered trials units (**South East Wales Trials Unit (SEWTU), Wales Cancer Trials Unit (WCTU) and Haematology Trials Unit**) that currently receive core funding from NISCHR (£3.2M) and Cancer Research UK (£3.2M). All Trials Units support both early phase and large multi-centre trials including many investigator-initiated trials (IIT). WCTU was ranked in the top 2% of UK research organisations by MHRA in 2012. We have built upon a broad foundation of Unit-led trials that include UK-wide multicentre cancer trials in leukaemia (e.g. **AML17** and **AML18**), colorectal cancer (e.g. **FOCUS3/MRC COIN** trial), breast cancer (**TACT, TACT2, ZICE, ABC**) and urological cancer (**ProtecT, STAMPEDE, PATCH**), clinical vaccine trials for colorectal cancer (**TaCTiCC**), and trials in inherited disorders (**TESSTAL, TRON**) and skin diseases (e.g. Psoriasis, Basal Cell Carcinomas). Opportunities to undertake basic research on trial cohorts have been exploited, building on successes in leukaemia (e.g. telomere length as a biomarker), colorectal cancer (e.g. pharmacogenomics in association with the COIN trial) and infection (e.g. UK-wide studies of infections and immune responses in peritoneal dialysis patients; **PERIT-PD** and **LEUK-PD**). The CREATE Centre is developing and leading efficacy testing trials of novel biologics in inflammatory and psoriatic arthritis, building on current translational activities, including taking two novel biologics through Phase I trials in 2013/2014 (**FE999301** and **NI-0101** in partnership with Ferring Pharmaceuticals and NovImmune SA respectively).
- **Raising the Unit Profile.** The Unit hosted major research symposia and conferences in Cardiff, for example, **the Wales Cancer Conference** 2011, **British Society of Immunology Summer School** 2012 (100 delegates from UK, Europe and US), British Heart Foundation sponsored **UK Platelet Group Meeting** 2012 (167 delegates from UK, Europe and US) and the **European Complement Workshop** 2009 (380 delegates from UK, Europe and US), and numerous meetings hosted by the Wales Gene Park. Researchers in the Unit have co-organised

international conferences during the REF period, e.g. **Oxygen Radical Gordon Conference** (Ventura, CA, Feb 2012), **Bioactive Lipids in Cancer, Inflammation and Related Diseases**, (Seattle, Sept 2011), **Immunology of Diabetes Society** (Seoul, South Korea, 2010), **Molecules to Medicines in Tuberous Sclerosis and Related Disorders** (Washington DC, 2013).

- **Building National and International Collaboration:** Capacity building collaborations were fostered with leading UK researchers in Cancer, Genetics and Immunology and international links with external universities built. These are fully described in Section e.

Research plans and objectives over the next 5 years. Our 5-year strategic aims are aligned with research strategies for CU and the College of Biomedical and Life Sciences, and set out specific mechanisms to enable the Unit to excel through consolidation and capacity building. Key aims are:

- **Grow additional Centres of Excellence:** We will renew and expand centres of excellence held by the Unit, as follows:
  (i) To promote our translational immunology research, and building on the ISSF award, we aim to establish a **Centre for Immunotherapeutics of Chronic Disease** with local support and funding from a Wellcome Trust Strategic Award (in 2014) followed by MRC Centre bid.
  (ii) To further promote patient-based research into cancer genetics, we aim to expand the **NISCHR Cancer Genetics Biomedical Research Unit**, seeking centre status from NISCHR in 2015.
  (iii) To promote research in rheumatoid disease, the AR-UK **Centre of Excellence in Biomechanics and Bioengineering**, established in 2012, will bid for non-competitive renewal in 2015.

- **Establish College research themes/University Research Institutes in I&I and ICG**. In 2014, I&I and ICG research themes will be expanded to include additional research groups from other College schools. This will be accompanied by significant new investment including new purpose built facilities and research infrastructure. Up to £200-300M will be invested in new research facilities at the UHW Campus as part of the "Innovation Systems" initiative led by the Vice Chancellor and Pro-Vice Chancellor for Research, Engagement and International. Both themes will bid to become stand-alone University Research Institutes.

- **Further build links with Industry.** We will increase collaborations with industry, including our current partners in large Pharma and SMEs, through presenting at key events including BioWales 2014, and organising site visits that will increase the number of industrial partnership bids and studentships (e.g. CASE Awards, MRC Industry Collaboration Agreements). We will build activities including commercial clinical trials, IITs, contract research, investigator-led studies, preclinical testing and translational research, utilising the Centres and facilities described in Section d.

- **Further develop international collaborations.** A nascent collaboration with Beijing Capital Medical University will develop into a joint Centre in Translational Medicine within the next few years, to work along side our newly established **Peking University-Cardiff University Cancer Research Centre** (see Section e).

- **Increase RCUK and EU funding**. We are proactively preparing for Horizon2020, through our membership of Vision2020 (an international group of organisations coming together under a global platform and including a number of UK and EU universities), arranging networking meetings with Wales Higher Education Brussels, and raising awareness of EU and European Research Council funding schemes. Key schemes have been identified, that will be applied for once calls open later in 2014. The number of our staff on MRC panels and boards increased throughout 2011 onwards (now 4) and we aim to increase active exchange of our strategic vision with MRC (through our Partnership Agreement) and other RCUK funders moving forward.

- **To promote translational research** by collaboration between I&I and ICG and in other Schools where there is expertise in cancer and the immune system.

- **To link more effectively with the NHS in Wales, in recognition of the translation**

imperative.

Responsiveness to national and international priorities and initiatives. Several external assessments (Cancer Research UK and previous RAEs) have highlighted our research strengths in priority health areas. Activities within the Unit closely match priorities outlined in 2011 by the Chief Medical Officer for Wales ("Our Healthy Future": healthy ageing, cancer, vascular disease, chronic conditions, infectious diseases, diabetes) (http://wales.gov.uk/topics/health/cmo/healthy/?lang=en), and contribute to health improvement initiatives endorsed by Welsh Government such as 'make a change4life', 'healthy sustainable communities' and 'cancer awareness'. Our research aligns closely with published strategies of funding agencies (MRC, BBSRC, Wellcome Trust, RCUK, British Heart Foundation, Arthritis Research UK, Cancer Research UK, Leukaemia and Lymphoma Research) and the commercial sector. In response to national priorities, both institutes built translational capacity through targeted external recruitment and expansion of clinical trial capacity, outlined earlier.

Effective mechanisms for the development and promotion of research. Unit strategy is developed by the School of Medicine Executive (chaired by Dean of Medicine) and Research Management Group (Chaired by Dean of Research). I&I and ICG have institute-based executives that include leads for research themes, post graduate research and teaching. Members of staff are informed about research funding opportunities through the School Research Office and the University's Research, Innovation and Enterprise Services (RIES). Research policy in both institutes is also developed during annual Research "Away Days". All members of academic staff have dedicated laboratory space (wet and/or dry). A School Research Equipment Fund (£100K pa) competitively primes new research initiatives compatible with strategy. Research throughout UoA1 is monitored through annual staff appraisals, where progress is reviewed and targets are set for the coming year. All grant applications are internally peer reviewed by at least one senior academic to promote interdisciplinary research and high quality.

Mechanisms for dissemination of research Public Engagement is academic-led, and funded through a ring-fenced SoM budget (£8K pa) providing a website, literature and a range of activities (www.cardiff.ac.uk/medicine/push), including monthly 'Science in Health" Public Lectures which provide an opportunity for the public and local sixth form students to listen to and meet with eminent guest speakers. A two-day '*Science in Health-Live*' event is held annually during 'National Science and Engineering Week', attracts over 800 sixth-form pupils from across Wales and involves the majority of Unit staff, from postgraduate students to professors, in delivering talks, demonstrations, science quizzes, science theatre, interactive exhibits and laboratory tours. Science in Health-Live was shortlisted in 2009 for the British Science Association's *Best Science Event Award,* and in 2012 for the '*European Competition for Best University Outreach and Public Engagement Activities*'. The Unit also hosts a biomedical sciences work-experience programme, to inform and inspire secondary school students throughout Wales who are considering studying medicine, health or biomedical sciences. Outreach activities delivered through the Wales Gene Park include workshops and conferences that have attracted 10,000 participants during the REF period and include a biennial 6th form conference involving over 2,000 pupils, and update sessions for healthcare professionals from the NHS and other partners from across the UK.

Examples of Unit public research dissemination include contributions to websites (including charitable organizations e.g. Arthritis Research UK, Tuberous Sclerosis Association UK), participation in the National Eisteddfod, Hay Book Festival and other festivals, and annual open days supported by Cancer Research UK, Leukaemia and Lymphoma Research and other charities. Patient representatives engage actively in research through NISCHR-supported PPI networks and through Wales Gene Park's works with Genetic Alliance UK. Patient groups are engaged early in the development of funding applications to charities and on trials management groups. High impact research achievements are advertised through University websites and newsletters, and regularly feature in local and national media. Members of the Unit have featured in local and national news reports, e.g. in 2012/13, BBC Wales, BBC Radio 4 Today Programme and Woman's hour, Radio 5 live, BBC2 Horizon program 'Defeating the Superbugs', and features in Guardian and Daily Telegraph. News reports have highlighted, for example, our achievements in: tracking patients infected with antibiotic resistant bacteria; new discoveries in telomere biology; explaining the role of CD8 T-cells in type-1 diabetes; and improving the management of

fibromyalgia. ReMEDy (the School of Medicine quarterly newsletter), reaches an audience of over 10,600 in hard copy and many more on-line, including alumni, major stakeholders in industry and local/national government.

Research groupings, their activities, their rationale, how they operate and their main achievements The Unit comprises 59.6 Category A FTE (total 76 staff members, including 15 ECRs), 4 Category C staff, and approximately 100 associated research support staff. There is extensive collaboration across the institutes and themes. Our researchers are clustered in three dedicated research buildings in adjacent locations on the Heath Campus: the Cancer Genetics Building, the Henry Wellcome Building and the Tenovus Building. The three are within 100m of each other and share core facilities, seminar rooms and social facilities. Joint seminars, social programmes and annual meetings are regularly held.

Immunology research in the Unit is in four overlapping themes:

- *Innate Immunity* investigates pathways to and clinical impact of dysregulated innate immunity in disease, and develops novel diagnostics and adjunctive therapies that target the pathways identified.
- *Adaptive Immunity* evolves novel strategies to target adaptive immunity in infection, autoimmunity and cancer. Research focuses on disease-relevant aspects of antigen presentation, regulation of T-cell effector function and vaccine design.
- *Infection* explores mechanisms governing host-pathogen interactions and applies knowledge gained to inform strategies for therapy.
- *Inflammation* interrogates the molecular and cellular mechanisms determining inflammatory disease transition to chronicity and applies the findings to discover new ways to prevent progression.

Cancer and Genetic Research in the Unit is in four overlapping themes:

- *Haematological malignancies* utilises molecular cell biology approaches to identify abnormalities associated with leukaemia and pre-leukaemia and inform the selection of candidate drugs that are then fast-tracked into clinical trials.
- *Solid Tumours* undertakes research on the genetics and basic biology underlying colorectal, breast, urological and head and neck cancers and uses data to identify mechanisms and treatment strategies that are tested in trials.
- *Tumour Pathology* delivers the basic biology, technologies and resources necessary to underpin clinical studies of tumorigenesis, metastasis and the control of tumour progression.
- *Medical Genetics* collects and collates large patient cohorts, including clinical trial cohorts, to identify and characterise cancer-associated inherited and somatic genetic variation and undertake functional studies and clinical trials based on outcomes.

Main Achievements of the Unit

- **Research publications:** The Unit has published >2100 research articles during the REF period. These include >215 publications in international journals with an impact factor >8.0, including Nature, Science, Blood, Proc. Natl. Acad. Sci. (USA), New England Journal of Medicine, Lancet, Lancet Oncology, Nature Medicine, Nature Immunology, Immunity, Journal of Clinical Investigation, Journal of Experimental Medicine, Journal of Clinical Oncology.

- **Development of Clinical Trials and Stratified Medicine:** In the assessment period, Unit researchers have:
  (i) Led multicentre clinical trials and associated pharmacogenetic studies that have informed cancer treatment: Prostate, MRC PR07, Colorectal, FOCUS 3 and COIN; Haematology, AML 16, 17 and 18, IMPAXT; Breast, TACT and ZICE.
  (ii) Led some of the earliest clinical trials of targeted therapy for inherited cancers (e.g. TESSTAL for renal tumours; TRON for neurocognitive deficits in tuberous sclerosis), and developed laboratory stratified medicine approaches to assess genetic biomarkers in cancer clinical trials (CRUK Clinical and Technical Hub Award).
  (iii) Led a multicentre trial in early Rheumatoid Arthritis (RA) (CARDERA) demonstrating that steroids plus a combination of disease modifying anti-Rheumatic Drugs is superior to standard therapy with methotrexate, now incorporated in NICE recommendations for early treatment of RA.

(iv) Led first multicentre Phase-I clinical trial of immunotherapy in type-1 diabetes utilising a vaccine (MonoPepT1De), funded by JDRF and Australian Health and Medical Research Council.

- **Diagnosis and Treatment of Inherited Diseases**: Unit researchers developed diagnostics for Mendelian disorders (MUTYH Associated Polyposis (MAP), cortical malformation), transferred these to the NHS and, in the case of MAP, commercialised their IP in the USA through licensing agreements to Myriad Genetics (approx. £400K in license income). This work was recognised by the award of a Queen's Anniversary Prize to the Unit in 2008.
- **Major grants awarded:** A list of Grants is provided in Section d. Some highlights during REF period include: Cancer Research UK Experimental Cancer Medicine Centre award (>£5M), three senior Wellcome Trust Investigator Awards (incl. one joint with Bristol University), one European Research Council Advanced Grant (€2.9M), ten Programme Grants (Wellcome Trust (x2), Leukaemia and Lymphoma Research (x5, including 2 renewals), Arthritis Research UK, British Heart Foundation, and Cancer Research Wales), three Senior Fellowships (Wellcome Trust, MRC, Cancer Research UK) and numerous Career Development Awards (Wellcome Trust, Arthritis Research UK, Kidney Research UK, Association for International Cancer Research, NISCHR, Marie Curie EU FP7). Large initiative awards include: Wellcome Trust/NISCHR Institutional Strategic Support Fund award (£4.5M, 65% ring-fenced for this Unit, awarded 2011); Wales Gene Park renewal (>£6M); Cancer & Genetics Biomedical Research Unit (NISCHR, £1.7M); Cancer Research UK Centre (£2.1M).

Mechanisms and practices for promoting research, and sustaining and developing an active and vital research culture Research staff in the Unit expect to deliver research that meets international standards of excellence and win external funding at a level commensurate with their seniority. Emphasis is placed on supporting staff to improve the quality of their research and the quality and success rate of their grant applications, benchmarking expectations to at least the median for UK medical schools and associated Russell group members. Grant applications are internally reviewed prior to submission by at least one experienced Senior Investigator.

Over the assessment period we have: (1) more than doubled the number of Unit researchers on funding panels (4 MRC, 1 EU, 3 Wellcome Trust, 10 NISCHR, 1 NIHR); (2) successfully lobbied through panels, Research Councils, Charities and Welsh Government for specific calls in our areas of research excellence; (3) increased our visibility with funders *via* proactively organised site visits (e.g., MRC Career & Training visit (2013), the Medical Directors of British Heart Foundation and Arthritis Research UK (2009, 2011, 2012), and Director of Wellcome Trust, Sir Mark Walport (2012)).

c. People, including:

Staffing strategy and staff development Staffing strategy and staff development operate within CU's Investors in People Framework. The University's commitment to the European Charter and Code for Researchers and the Code of Conduct for the Recruitment of Researchers has been recognised by the European Commission with an "HR Excellence in Research" accreditation. It is a requirement of both UoA1 components that all staff involved in recruitment and retention undertake formal Equality and Diversity training. Judgments about promotions in both groups are based upon excellence and made by the School Promotions Panel and the University's Academic Promotions Committee in accordance with a formal "Scheme of Assessment" which applies equally to all staff taking into account their contractual arrangements and all relevant equality and diversity issues.

Staffing strategy within the Unit is underpinned by nationally recognised CU-wide initiatives:

- The **Cardiff Researcher Programme** is designed for staff employed on research only contracts at CU and links with Vitae's Researcher Development Framework to provide research staff with free workshops, online modules and one-to-one coaching in over 100 research-relevant topics.
- In 2011 CU became the first Russell Group University to gain the **'*Investors in People*'** standard. This nationally recognised accolade demonstrates an organisation's commitment to valuing staff and promoting good management practice.
- The CU **Leadership and Management Development Programme for Research Team Leaders** has provided in-depth training to over 140 staff members in its first 5 years - more than

completed the Leadership Foundation's programme for Research Team Leaders across the rest of the UK. The Programme was shortlisted for the 2010 **Times Higher Award** for Outstanding Contribution to Leadership Development.

Relationship between staffing and research strategy, and sustainable staff structure. Turnover of staff during the REF period has been low and mainly from retirements. To maintain and enhance our research focus, the Unit recruited senior staff (focusing on key clinical academic appointments), developed the research careers of existing staff, and provided support to its most active researchers during the REF period. Of the non-professorial staff returned as lecturer or above in RAE2008 (n=17) and who are being returned to REF2014, 13 have been promoted, to SL (n=2), Reader (n=5) or Professor (n = 6) during the REF period. Various members hold Visiting or Honorary Professorships in International Universities (see Section e), and we have hosted visiting scholars from Australia, France, Netherlands, New Zealand, Pakistan, Japan, Taiwan, and Italy.

Support for career development and integration of researchers
All staff participate in a structured career development programme, including a **formal annual appraisal** consistent with the '*Concordat to support the career development of researchers*'. Appraisals are conducted by senior staff, and for clinical academics, are **Follett-compatible joint appraisals** with NHS line managers. The Unit operates an **induction programme** for new appointees, setting out expectations, structures and support mechanisms for research in the Unit. Early career recruits are allocated a mentor and a probationer to provide support and monitor progress during the first three years in post. The School provides funding for staff wishing to attend the many training courses offered by the University and other approved providers. A major staffing strategy in the Unit has been to invest in Early Career Researchers (ECRs). The Unit has developed a culture of fellowship mentoring and has a proactive ECR support network led by a **Senior Academic Director of Postdoctoral Studies** who oversees the career development needs of ECRs including training in teaching and lecturing, grant writing, mentoring and general career advice, instructing supervisors on research and career needs of fellows, and formal progress reviews in the penultimate year of a Senior Fellowship to underpin progression to an on-going contract. In a report from visiting members of the MRC Training & Career Group (11/2012), our ECR support policies were highlighted as examples of good practice and key points recently used to inform MRC recommendations to Universities on employment of Fellows.

The Unit supported **three Senior Fellows** (MRC, CRUK, Wellcome Trust) and **three Wellcome Senior Investigators** during the REF period. The number of intermediate/junior level Fellowships in the Unit increased markedly during the REF period (n=4 in RAE2008, n=18 REF2014). These include **two Wellcome Trust University Awards, a Wellcome Trust Career Development Award, a Wellcome Trust Clinical Intermediate Fellow, a Wellcome Trust Sir Henry Dale Fellow, two Non-clinical Arthritis Research UK Career Development Fellowships, and Arthritis Research UK Career Progression Award, four Marie Curie Fellowships, a British Lung Foundation Fellowship, a Kidney Research UK Fellowship, three NISCHR Fellowships, a Myrovlytis Trust Fellowship and a Kenyon Gilson Foundation Fellowship**.

Unit staff won Travelling Fellowships supporting extended international placements (**EU Marie Curie to Vanderbilt University, USA; Arthritis Research UK to Monash Institute for Biomedical Research, Australia**). Such schemes have provided an invaluable training opportunity and allow retention of researchers with the potential to develop as independent group lead. Building on the success of our previous Wellcome Trust Value in People awards ISSF/NISCHR funding provided fellowship, bridging and seedcorn awards to Unit staff to support the development of applications for external funding. Of Unit ECRs now holding their own named fellowships or awards, 40% were initially supported through these internal support schemes. A European consortium led by Cardiff, Amsterdam and Vienna was awarded a FP7 Marie Curie Initial Training Network award "**European Training in Peritoneal Dialysis (EuTRiPD)** of €3.2M in 2012. The consortium aims to improve treatment and research in peritoneal dialysis and will host 12 trainees to PhD level in aspects of peritoneal dialysis research.

Evidence of how the submitting unit supports equalities and diversity (E&D)
The Unit appointed an E&D lead in 2012. An **Equality, Diversity & Human Rights committee** has been formed in the School, including staff working in research, teaching, administration, and healthcare, to establish good practice in relation to all relevant activities (including undergraduate

and postgraduate training). Recommendations for improvements in working practice adhere to existing national (Welsh Government, GMC, Royal Colleges, Rights commissioners) and international (WHO, Nuremberg Code, Declaration of Helsinki) policy frameworks.

Notable achievements include: CU and SoM both hold **Bronze Athena Swan Awards**. SoM won its award in 2013 and is ready to apply for Silver in 2014. In 2012, the University introduced a mandatory online E&D module for all staff. This provides an up-to-date overview of rights and responsibilities with respect to the UK's E&D legislation and is supplemented with classroom-based training. There is a mandatory E&D training session for all Chairs of recruitment panels. Bespoke sessions for female staff "**Confidence Building for Female Academics**" are highly valued. In 2013, for the third consecutive year, the University was included in the **Stonewall index** of Top 100 Employers, in recognition of its commitment to equality for lesbian, gay and bisexual employees. At 55th, it is one of only six universities to feature in this year's index.

Effective integration of clinical academics and NHS-employed active researchers. Several NHS-employed active researchers are members of the Unit's research teams and many have won funded research sessions to work with Unit teams through the **NISCHR Academic Health Sciences Centre (AHSC) Clinical Research Time Competitions**. The Unit encourages integration of clinical and non-clinical academic staff with many themes led by joint non-clinical and clinical heads that deliver fundamental and applied research of translational relevance. Most clinical leads are practising clinicians and several are speciality leads in their NHS roles, for example, in Endocrinology, Dermatology, Oncology, Rheumatology, Gastroenterology and Haematology.

Other examples of integration of Unit academics and NHS researchers include: **1)** the established partnership between Cardiff and Vale UHB and SoM that includes an integrated R&D strategy and a jointly funded R&D Director to facilitate translation of basic and clinical research; **2)** the NISCHR and CRC-funded **Registered Research Groups** (**Welsh Arthritis Research Network (WARN), Microbiology & Infection Translational Research Group (MITReG), All Wales Kidney Research Network (AWKRN), and Cardiovascular Research Group-Cymru (CRG-C)),** all-Wales networks that include clinicians, clinical trial experts and service providers and facilitate collation of core clinical data, patient recruitment to trials and collaborative interactions with industry; **3)** the **South East Wales Academic Health Sciences Partnership (SEWAHSP)** collaboration that brings together all the Health Boards, Trusts and Universities in SE Wales to collaborate in R&D; **4)** the recent appointment of a new Chair in Medical Oncology with a specific remit to involve local clinicians and develop early phase cancer clinical trials to fill a translational gap; **5)** academic-NHS collaborations drive research on inherited and acquired bleeding disorders that has contributed to clinical trials and changed patient management.

Research students

1. Effective and sustainable doctoral research training. The Unit hosts an annual PhD Studentship Competition that awards up to four studentships per year, funded from MRC and Unit sources; with the number boosted by externally-funded studentships. There are currently 105 PhD and 23 MD higher degree candidates in the Unit. Most PhD students are on 3-year programmes and submission rates have been >97% for 6 of the last 8 years; we are increasingly investing in four-year programmes that include a MRes in Y1. Historical poor completion rates for MD students have been tackled by requiring a minimum of 2 years study and by increased surveillance of projects and supervisors. Students come from across the UK/Europe and many have won prestigious conference awards, including from the British Society of Immunology, British Society of Haematology, the UK CLL Forum and Keystone Symposia. A major aim for the next 5 years will be to develop a stand-alone 4-year PhD scheme in the Unit with support from a major funder (e.g., Wellcome Trust or British Heart Foundation).

Clinical PhD trainees on the **Welsh Clinical Academic Training Scheme (WCAT)** are supported and mentored in the long term to enable them to become independent investigators. These are the run-through supernumerary Lectureships that provide training from entry into a 3-year PhD Training Fellowship through to competency based CCT. Since the launch of the WCAT scheme in 2010, the Unit has hosted 7 WCAT fellows (from 25 awarded in all medical specialities across Wales).

The **SoM MRes in Biomedical Research** (established 2011) offers intercalating medical students and science graduates the opportunity to explore, analyse and use, existing and developing molecular and experimental medicine, laboratory or population-related research techniques. In addition to being a "stand-alone" degree, the MRes can form the introductory year of a 4 year (1+3) PhD Programme. Of the first intake (7 students), five went on to PhD research and one to graduate-entry Medicine. The 2012 intake was increased to 13 students, all of who graduated.

2. Evidence of a strong and integrated research student culture. The Postgraduate Research (PGR) Office in the SoM oversees the monitoring of PGR students. PGR students organise an **annual Post Graduate Research Day** featuring research talks, posters and presentations from high profile external academics (e.g., Sir Mark Walport, Director, Wellcome Trust in 2012). The CU Graduate College (http://www.cardiff.ac.uk/ugc) was established to ensure a comprehensive and integrated approach to provide a high quality experience for all CU postgraduate research students and enhance that experience. Activities include student-led conferences, training and development programmes, and support for interdisciplinary research and facilities for networking. **CU Research Opportunities Programme (CUROP)** funds undergraduate summer placements in a research environment. Since its introduction in 2011, the Unit has hosted 35 CUROP students. The Unit has an active **ERASMUS programme** with the University of Novara, Italy and is developing other links.

We will continue to prioritise the training of the next generation of clinical and non-clinical scientists through PhD and fellowship schemes and by intensive mentoring from the earliest opportunity. Already active in engaging Medical Students in research, Unit staff embraced the **Wellcome INSPIRE programme**, led the CU application and this year (2013) hosted more than 30 students for summer and other lab placements.

3. Evidence of CASE awards and application of technology generated by research students. Two PhD CASE awards are active within the unit, both jointly funded by the BBSRC and GSK.

d. Income, infrastructure and facilities

Research Income: The value of new grants awarded for the Unit has almost doubled over the period from £12.8M in 2007-2008 to £23.2M in 2011-2012 (total value of new grants awarded during each period). We note that grant spend was highest for 2008-2010, due to significant infrastructure spend on the PETIC facility. Income continues to be strong and for the period August 2012- July 2013, the Unit attracted £25.1M in new grant capture. Active grants within the Unit stand at £59M, which includes 2 **Wellcome Trust Senior Investigator Awards** (and a third joint with Bristol University), a **European Research Council Advanced Grant** and **10 Programme Grants** (The Wellcome Trust x2, The Leukaemia and Lymphoma Research x5, Arthritis Research UK, British Heart Foundation and Cancer Research Wales). Several initiative awards underpin research within the Unit and bridge the gap between basic and applied research. These include a **Wellcome Trust/NISCHR sponsored Institutional Strategic Support Fund (£4.5M)**, the **Wales Gene Park (£6M in period),** a NISCHR sponsored **Cancer & Genetics Biomedical Research Unit (£1.65M)** and a **Cancer Research UK Centre** (£2.1M).

Nature and quality of the research infrastructure and facilities:

- The Unit's translational research is supported by a purpose-built **Clinical Research Facility (CRF)**, opened in March 2007 as part of a Wellcome/Joint Infrastructure Fund bid. The CRF is a registered UK CRC Experimental Medicine site, which supports translation of basic biomedical science into clinical practice. The CRF (12 beds) is part of the main hospital and in close proximity to essential research and clinical services. The CRF undertakes commercial and non-commercial studies including the AR-UK/NISCHR sponsored CREATE Centre (£0.4M), and is supported by expertise available within **two CU based UKCRC registered trials units (SEWTU & WCTU**, described earlier**).**
- Technology platforms are managed and operated through **Central Biotechnology Services (CBS)** to support both internal and external (CU, cross-HEI and industrial) researchers. Since 2008, CBS has received an equipment investment of £2.3M. Core technologies offered include multiparameter flow cytometry, proteomic mass spectrometry, surface plasmon resonance and DNA sequencing.
- A dedicated animal facility (including embedded Cat-3 laboratory) provides a barrier area for the housing and production of genetically modified mice, houses small animal imaging facilities

including PET/SPECT, X-ray, radio-isotope, fluorescence and luminescence imaging for experimental models. **CU Brain Research Imaging Centre (CUBRIC)** provides other experimental imaging, including experimental magnetic resonance imaging (MRI) and magnetic resonance spectroscopy.

- Provision of human research imaging is supported by the **Wales Research and Diagnostic PET Imaging Centre (PETIC)**, and **Cardiff University Brain Imaging Centre (CUBRIC).** PETIC represents a £16.5m investment by Welsh Government, is the only PET facility in Wales and is jointly managed by CU and the UHB to deliver research and service. CUBRIC, one of very few UK facilities to combine Structural and Functional Magnetic Resonance Imaging and Magnetoencephalography, supports the Unit's activities in clinical trials in inherited disorders, and the AR-UK Centre for Biomechanics and Bioengineering. CU funding in excess of £30M has recently been confirmed to build CUBRIC2.
- The **Wales Gene Park** provides next generation sequencing facilities and bioinformatics support for the Unit. With the acquisition of an Applied Biosystems 5500xl SOLiD sequencer in 2012, researchers have access to highly parallelized DNA sequencing for a wide range of workflows including whole exome and genome sequencing, whole transcriptome (RNA-Seq) analysis and bespoke applications in areas such as tumour mitochondrial DNA and telomere fusion analysis.
- A state-of-the-art **Lipidomics mass spectrometry (Cardiff Lipid Group)** facility funded by the Wellcome Trust, European Research Council and British Heart Foundation and embedded in the Unit, provides new generation tandem and Orbitrap mass spectrometry to Unit researchers and external collaborators and currently holds £5.2M in active grant income.

Policy and practice in relation to research governance CU and Cardiff & Vale UHB provide a single integrated Academic and NHS review procedure for the approval and ethical review (including national and local ethical reviews) of clinical and non-clinical research. CBS has received ISO 9001 and 17025 accreditations. In accordance with the Human Tissue Act 2004, CU holds one Hub and one Satellite Research Licence. The Hub (Licence No. 12422) covers research projects from both CU and Cardiff and Vale UHB activities within the SoM while the Satellite (also Licence No. 12422) covers research in affiliated schools (e.g., Bioscience, Pharmacy). The Human Tissue Act Compliance Team oversees governance/compliance issues.

e. Collaboration or contribution to the discipline or research base

Effective academic collaboration with external bodies, such as NHS Research and Development, and/or with industry, government agencies.

Unit Researchers actively participate in numerous collaborations at university, national and international levels. These are highlighted in the following sections, and include NIHR/NISCHR sponsored initiatives, KTP and other forms of collaborative partnerships with industry, local participation in R&D community frameworks within CU (including NHS trusts) and Wales, externally funded research networks and centres that integrate members from various CU Schools, and large scale partnership awards involving other UK universities, European consortia or international organisation. Investment in such initiatives has been obtained through awards from funding agents such as EU, MRC, The Wellcome Trust, CRUK, Arthritis Research UK, British Heart Foundation, often underpinned by matched funding from CU. More detail is provided below.

International collaborations

Unit staff have administered EU FP7 Network of Excellence (€10M), and FP6 (€11.9M) and FP7 (€5.98M) Collaborative Project awards that are focused on innovative chemokine-based therapies for autoimmunity and chronic inflammation, and antigen-specific immunotherapy in Type-1 Diabetes (listed earlier). Unit staff are also principle partners in an EU FP7 Marie Curie Initial Training Network (**European Training in Peritoneal Dialysis, EuTRiPD**), which provides broad–based training and engagement in peritoneal dialysis research. In association with The Dutch Kidney Foundation, Kidney Research UK and EuroPD, local and international training courses are provided by secondment in 9 European centres of excellence and industrial partners (Baxter Healthcare, Abbot and Zytoprotect). Unit links with Capital Medical University, Beijing were awarded ***International Collaboration of the Year*** in the **2012 Times Higher Awards**. A major recent international development led by the Unit is the Cardiff-Peking Cancer Institute with an initial investment of £5M from CU and matched funds from Peking University - a unique relationship, the

first of its kind in Europe (2013). Joint appointments, joint projects, shared infrastructure, student and scientist exchanges and other initiatives create a powerful research centre benefiting from the very different strengths in the collaborating Universities.

National and Cross HEI Collaborations

A formal collaboration with other Universities in the South West (Bristol, Bath, Exeter) has been agreed under the **Great Western 4 (GW4)** initiative. Other existing UK links include Glasgow, Newcastle and Queen Mary Universities as partners. Additional examples are include participation in MRC, CRUK and EU sponsored stratified medicine programmes in arthritis, cancer and peritoneal dialysis. **Severnside Alliance for Translational Research** (**SARTRE**; http://www.sartre.ac.uk/) is a strategic partnership between CU and Bristol, established in April 2009 funded by a £1.8M MRC grant to address translational gaps via preclinical and clinical research and align the translational potential of research across the two institutions, particularly in areas relevant to the Unit - chronic disease, infection and cancer, with additional funding from a MRC DPFS portfolio (> £0.5M). On the national (Wales) level, four NISCHR funded **Registered Research Networks** (see also Section c), led by Unit members, link universities, health boards, research institutes, general practice, public health and trials units across Wales and work to increase the quality and quantity of health and social care research in Wales. This network approach has increased research capacity in Cardiff and across Wales through increasing grant capture, fuelling portfolio growth, aiding patient recruitment and providing case studies of research projects that show demonstrable patient benefit.

Working with Welsh Government, NISCHR launched its **Academic Health Science Collaboration (AHSC)** in 2011 to promote health research in Universities and the NHS in Wales. In addition to the awards noted above, NISCHR AHSC supports research in the Unit through: ***1)*** matched funding bids to Wellcome, MRC and Charities; ***2)*** tissue and sample banking (e.g., the **Wales Cancer Bank, Pathobiology in Early Arthritis Consortium (PEAC)**; ***3)*** recruitment to local and multi-centre clinical trials; ***4)*** supporting technology transfer to NHS diagnostic laboratories and clinical services (e.g. translation of complement diagnostics to create a **UK Centre for Complement assays**); ***5)*** funding protected sessions (up to 40% FTE) for NHS clinical and lab staff to develop collaborative research programmes; ***6)*** creating the **South East Wales Academic Health Science Partnership (SEWAHSP)** to facilitate collaborative work between Universities, funding bodies and industry to addresses Welsh Government policy priorities in health, economic development and science.

Intra-university collaborations.

Our researchers collaborate locally across clinical and basic interests via six University wide Interdisciplinary Research Centres. Six were established during the assessment period: **Cardiff Regional Experimental Arthritis Treatment & Evaluation Centre (CREATE)** (2012); **Arthritis Research UK Centre of Excellence in Biomechanics & Bioengineering** (2009); **European Cancer Stem Cell Research Institute, Cardiff Cancer Research UK Centre** (2009); **Centre of Excellence for Leukaemia and Lymphoma Research** (2010); **Cancer Genetics Biomedical Research Unit** (NISCHR, 2012), and **Cardiff Cancer Collaborative**. The previously established **Wales Gene Park** was awarded >£6M follow-on funding in the REF period. Three Unit staff are group leads in the **Arthritis Research UK Centre for Biomechanics and Bioengineering,** supported by a £10M award from Arthritis Research UK and CU. The Centre links 7 Schools to integrate research in engineering, cell biology, immunology, genetics and imaging.

Industry collaborations.

Unit researchers collaborate extensively with industrial partners. For example, an NIHR i4i Challenge Award (with **Mologic Ltd**) is developing novel medical technologies that target cell migration and applying these to treatment of chronic inflammation, research that exemplifies bridging of the gap between innovation and translation to clinical pathways. Research into the use of T-cell receptors as therapeutics (with **Immunocore Ltd**), funded by a Knowledge Transfer Partnership (KTP), translates basic biology into a new paradigm for immune destruction of tumours. In another KTP project, basic research on genome stability is being translated into a new technology to measure genome-wide ultraviolet light-induced DNA damage and apply it in photogenotoxicity testing in human cells. Several other Unit-led projects involve investigator awards from pharmaceutical companies (e.g., **Activiomics, Amgen Inc, Complete Genomics**

Inc., Genentech, Spirogen Ltd, Ipsen Pharmaceuticals, Apoxis SA, Janssen Research and Development, NAPP Pharmaceuticals, MedImmune, Novartis, Pfizer, GSK, Qiagen Limited, UCB Pharma, Ferring Pharmaceuticals, Hoffmann La Roche, Baxter), and small biotech (e.g., **Spirogen, Apoxis SA, NovImmune SA, BioVitrum, Viropharma**) and manufacturing CROs (e.g., **Biovian, Finland, Lonza, UK**), and utilise the translational research structures described earlier. Recent successes include a Wellcome University Translational Award for cytokine therapeutics development (£0.9M) and new applications for complement therapeutics (with **Viropharma**; £0.5M).

Indicators of wider influence or contributions to the discipline or research base
Unit staff serve as Chairs or members of numerous Boards, Committees and Advisory Groups; the following summary is limited to major National and International contributions.

Chairs and Senior Board appointments
Barnes: UK Clinical Mycology Network Chair; Royal College of Pathology Specialist Advisory Committee Member. **Barrett-Lee**: NCRN/NCRI Breast Cancer Clinical Study Group Vice-Chair. **Burnett**: NCRN/NCRI AML Clinical Study Group Chair. **Collins**: UK CRN Non-Malignant Haematology speciality group Chair. **Mason**: NCRN/NCRI Prostate Clinical Study Group Chair. **Morgan**: MRC Council; International Complement Society Immediate Past President. **Pepper**: UK CLL Forum Scientific Secretary **Piguet**: European Society For Dermatological Research, Immediate Past-President. **Sampson**: International Scientific Advisory Board (USA) to Tuberous Sclerosis Alliance; Medical advisor to Tuberous Sclerosis Association. **Topley**: EURO-PD President

Honorary positions
Dayan, Sewell, Topley: NISCHR Senior Faculty. **Jiang**: Honorary Professor, Peking University. **Morgan**: Spinoza Professorship Universities of Amsterdam and Utrecht; NISCHR Senior Faculty. **O'Donnell**: Honorary Professor, Faculty of Medicine, University of the Republic, Montevideo. **Piguet**: Honorary Professorship, China Medical University, Shenyang, China.

Participation in peer-review
Unit researchers serve as editorial consultants/editorial board members for leading international scientific journals and/or Research Councils. Editorial board memberships are too numerous to list. Major contributions include:
Chief Editorships: Moser, Frontiers in Immunology.
Emeritus Editorships: Topley, Peritoneal Dialysis International**.**
Associate Editorships: Clayton, Exosomes; **Fegan**, British Journal of Haematology; **Gallimore**, Immunology; **Morgan,** Molecular Immunology, European Journal of Immunology; **Piguet**, British Journal of Dermatology, Journal of Investigative Dermatology, Cellular Microbiology.

Funding panel membership
Unit researchers are members of research grant panels for major national and international funders, including:
Harris, Macular Degeneration Research (MDR) grant review panel. **Jones**, AR-UK Research Sub-committee. **O'Donnell,** Wellcome Trust Physiological Sciences Panel, MRC Non-Clinical Training and Career Development Panel, EU Marie Curie Grants panels. **Pepper**, Leukaemia and Lymphoma Society Grants Panel. **Piguet**, British Skin Foundation Large Grants Committee. **Sampson, Moser**: Wellcome Investigator Awards Panel. **Wilkinson**, MRC Infection & Immunity Board. **Mason, Chester, Barrett-Lee**, Cancer Research UK Review Panel

Distinguished Fellowships and awards
During the period Unit members have received the following Awards:
Hall: Order of the British Empire (OBE). **Morgan**: International Advisor to Capital Medical University, Beijing. **Mason**: Worshipful Society of Apothecaries, William Farr Medal, **Price**, **O'Donnell:** Fellow of the Society of Biology, Marie Curie Excellence Award. **Price**: Royal College of Physicians Graham Bull Prize in Clinical Science, **Moser**: Royal Society Wolfson Research Merit Award, **Morgan**: Learned Society of Wales.