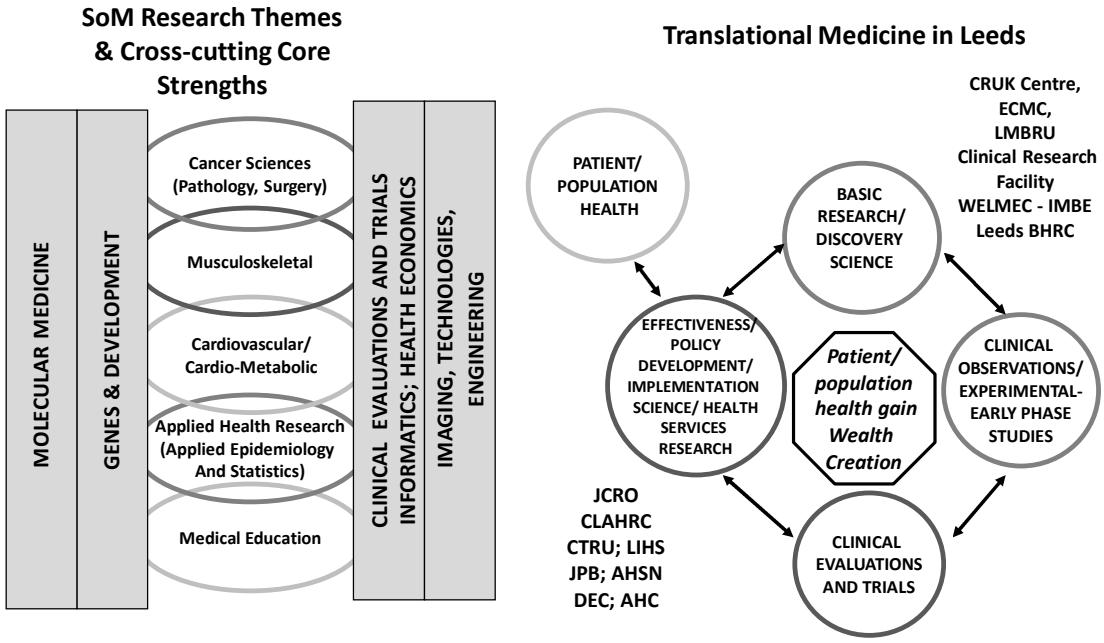
Institution: The University of Leeds

Unit of Assessment: UoA1 Clinical Medicine

Overview. *Organisation and Structure:* Research in Medicine at the University of Leeds is largely delivered within the School of Medicine (Dean, **Stewart** FMedSci), the largest of 4 Schools within the Faculty of Medicine and Health. Our School Research Strategy (see figure) is predicated on selectivity, focusing on areas of International Excellence that encompass the full translational pathway from discovery science to applied health research, with the collective aim of improving patient and population health and wealth creation (http://medhealth.leeds.ac.uk/medicine/strategy). The School Research Strategy sits within a broader University-wide Biomedical Health Research Strategy that involves significant collaboration with University researchers submitted in UoA2,3,4,5 and 12 as well as key NHS partnerships (http://medhealth.leeds.ac.uk/strategy). For REF2014, School research within **Musculoskeletal, Cardiovascular** and **Cancer & Pathology** groupings as well as the cross cutting theme **Genes & Development** is presented in A1; Applied Health, Epidemiology Evaluation and Trials Methodology is presented in A2, Nursing in A3 and Medical Education Research in C25.

Medical School research strategy at the University of Leeds



AHC=Applied Health Co-operative; AHSN=Academic Health Science Network; BHRC=Biomedical and Health Research Centre; CLAHRC=Collaboration for Leadership in Applied Health Research and Care; CTRU=Clinical Trials Research Unit; DEC=Diagnostic Evidence Co-operative; ECMC=Experimental Cancer Medicine Centre; IMBE=Institute of Medical and Biological Engineering; JCRO=Joint Clinical Research Office; JPB=Joint Partnership Board; LIHS=Leeds Institute of Health Sciences; LMBRU= Leeds Musculoskeletal Biomedical Research Unit; WELMEC=Wellcome Trust - EPSRC Centre of Excellence in Medical Engineering

The strengths and focus of the distinctive **Musculoskeletal Research** grouping were recognized through the award of an NIHR BRU in 2008, renewed at an enhanced funding level in 2012 (total £12.7M). Clinical researchers and biomedical scientists work closely with colleagues in the multidisciplinary Institute of Medical and Biological Engineering (iMBE), awarded the Queen's Anniversary Prize in 2011. Leeds' **Cardiovascular Research** grouping comprises an interdisciplinary team of life scientists, tissue engineers, imaging experts, epidemiologists, biostatisticians and clinical researchers focusing on the challenges of cardiovascular disease associated with Type 2 diabetes mellitus and innovative approaches for vascular repair. This work has been recognized by 5 Programme grants from the Wellcome Trust and British Heart Foundation (BHF), as well as a BHF Chair, BHF Senior Fellowship, BHF Intermediate Research Fellowship and ERC Consolidator award. Addressing the need for "50 healthy years after 50", researchers in both **Musculoskeletal** and **Cardiovascular Research** groupings are part of the £11.2M WELMEC led by iMBE and the £7.3M EPSRC-BBSRC-TSB Innovation Knowledge Centre in Medical Technologies, further underlining the distinctive Leeds approach to translation. The ability to draw together an inter-disciplinary mix of basic scientists and clinical researchers to focus

on clinical challenges is further exemplified in our **Cancer & Pathology Research** grouping, awarded £9.8M as a CRUK Centre in 2011 and recognized as a CRUK/NIHR ECMC in 2007 and again in 2012. We were one of only 8 designated "clinical hubs" contributing to Phase 1 of the CRUK Stratified Medicine Programme and are participating in Phase 2. A particular strength has been embedding the "dearth" areas of surgical and pathological sciences into our **Cancer and Pathology Research Programme**; our success in delivering benefits to patients within this REF period is seen in the 7 cancer and pathology impact case studies (CS 2,3,4,5,6,9 and 10). Molecular Medicine feeding through **Genes & Development** continues to be a major research strength, notable successes being over £9M in NIHR funding and the **Sir Jules Thorn Trust Award** in 2009 for identification of recessive disease genes. The grouping has pioneered diagnostic testing that is now used on an **international scale** (CS 8).

A close working relationship with the NHS is essential to deliver our strategy for translational research. The Medical School has well established links with hospitals across Leeds and Bradford, but for research within A1 the **Leeds Teaching Hospitals NHS Trust (LTHT)** is the key partner in delivering patient focused research as reflected by our impact case studies. LTHT is the UK's second largest NHS Trust (2.7 M tertiary catchment population, 3,200 beds, 700,000 outpatient visits and 200,000 inpatient and day cases/year) with an annual budget of over £1 billion. In 2008 the **JPB** was established chaired (jointly) by the University's Vice-Chancellor and the LTHT Chief Executive, overseeing research groupings co-localised with sites of clinical service delivery to facilitate and expedite our strategic objective of delivering translational research with impact for patients. Translational **Musculoskeletal Research** is delivered via the NIHR Leeds Musculoskeletal BRU at Chapel Allerton Hospital (CAH), bringing together imaging and rheumatology research addressing patient needs in inflammatory diseases and musculoskeletal medicine. **Cardiovascular Research** laboratories and facilities within the state-of-art Leeds Institute of Genetics, Health and Therapeutics (LIGHT) Building are immediately adjacent to Leeds General Infirmary (LGI) where service delivery for patients with cardiovascular diseases is based. **Cancer & Pathology Research** is focused on the St. James's University Hospital (SJUH) Campus with laboratories in the University Wellcome Trust Brenner and Clinical Sciences Buildings together with clinical facilities in the new Bexley Wing providing access for patients to clinical trials, outstanding clinical research platforms and material for basic/translational research. . This relationship was strengthened in 2012 with the opening of the NIHR Leeds CRF (LCRF) with in- and out-patient facilities at SJUH, now expanded to include experimental medicine activities in musculoskeletal medicine at CAH and cardiovascular diseases at LGI.

Research Strategy / Research Groupings, their activities, rationale, operations and Main Achievements.

Throughout this REF period, our A1 research has a vision to improve patient and population health and reduce health inequalities, at local, national and international levels through the delivery of research excellence with impact. Our strategy has been to work with our partners to provide a focus for Translational Science. We believe that a unique strength, delivering research excellence and impact, arises from the strong partnership between clinical medicine and high quality research groups in the physical and biological science and engineering. Our A1 Research groupings in **Musculoskeletal, Cardiovascular** and **Cancer & Pathology** and the cross cutting **Genes & Development** are all areas of multi-disciplinary strengths and fully endorsed in the joint University-LTHT strategic goal "*To achieve academic excellence and expand the boundaries of healthcare*". This has facilitated close synergistic working relationships between University academics and NHS colleagues, reflected in our return of 13 Cat C staff. **"Innovation"** is a crucial part of our mutual strategy, cognisant of our important role as wealth creators within the Life Health Sciences Industry. Strategic use of University HEIF funds aligned to Stratified Medicine and Medical Technology hubs (www.leeds.ac.uk/info/125078/sector_hubs) has created new opportunities with Pharma, SME's and biotechnology companies. Our recent success with an NIHR DEC (**Selby**; £1M, 2013-2017) will generate high quality evidence on clinical validity, utility and cost-effectiveness of diagnostic technologies for use in the NHS; this will ensure the timely dissemination of results to key stakeholders (e.g. NHS commissioners and NICE), to maximise impact and accelerate adoption and is one of the core missions of the recently designated Yorks & Humber AHSN. Our NIHR Health Technology Co-operative (£800k, 2013-2017) in colorectal therapies will further strengthen the bridge between physical sciences, engineering, and medicine

as they develop novel surgical technologies.

Institutional support for our strategy: In 2009, the University and LTHT invested £10M and £3.5M, respectively, to create the **Leeds BHRC** supporting multidisciplinary translational research. Governance is via the JPB with external input and strategic guidance from a Scientific Strategy Advisory Committee. The BHRC supported capacity building through an innovative **Senior Translational Research Fellowship (STRF)** scheme that recruited excellent scientists expected to become future leaders of interdisciplinary translational research (4 STRFs returned within A1, see below). The BHRC also invested in **Platform Technology Groups** enhancing the scientific infrastructure in Leeds to support translational research. Technology groups were created in Medicinal Chemistry/Chemical Biology, BioScreening and in Bioinformatics, facilitating proof-of-principle studies in drug discovery, biomarker detection and design and translational genetics, e.g. the FcγRs, IL-7 and its receptor (EU-FP7 funded; patent application pending). The short-term £600K "**Problem Solving Fund**" unblocks specific obstacles to translating research, yielding a 7 fold investment return in follow-on funding for translational research (total external awards £4.2M; 12 grants to A1 researchers delivering £3.5M of further funding). Strategic use of LTHT flexible support funding and University overheads have built research governance structures (joint clinical research management) and research design services, and increased capacity within the Leeds CTRU and health services research (together comprising the **Leeds AHC**). The CTRU (largely returned in A2) has rapidly expanded with a collective trials portfolio (across UoA1 and UoA2) totalling £46 million of external income, currently managing >17,500 patients in 50 trials. Our NIHR portfolio across the University/LTHT partnership is extensive (£56M income over the REF period). Additional investment from the University-LTHT partnership supports our joint translational research agenda. A £25M investment houses the NIHR-Leeds Musculoskeletal BRU that provides state-of-the-art musculoskeletal imaging and creates a seamless research environment facilitating translation of basic biomedical research into innovative clinical practice and improved patient care. LTHT provided "pump-priming" support (£2.2M) for academic posts including two Professorial appointments in 2012, to develop a programme of radiotherapy research (led by **Sebag-Montefiore**). The LTHT Charitable Foundation has funded high technology radiotherapy infrastructure (£5M) and is funding academic radiology for cancer imaging studies (£1M funding agreed in 2013). LTHT and the University have jointly developed novel digital pathology technologies supported by NIHR, EPSRC and Wellcome Trust (**Quirke**). Joint contracts and appraisals for NHS clinical academics (many now recognised through a new University Associate Professor appointment) provide protected research time via the NIHR Research Capacity Funding stream and the LTHT Charitable Foundation. In addition, a total of £1M pa is allocated by LTHT and the Leeds Teaching Hospital Charitable Foundation in support of strategic research groupings, including 5 clinical fellows for the Leeds Musculoskeletal BRU, pilot project funding and protected time in clinician job plans. The close working between the CTRU and A1 researchers based upon innovative trials design is exemplified by our impact case studies (CS 3, 4, 6 and 10). Ongoing collaborative work with CTRU focuses on trials (many funded through NIHR) in **Musculoskeletal, Cardiovascular** and **Cancer & Pathology** research, biomarkers and devices and in methodology development. This further illustrates our strategy in action, bringing together researchers and clinicians with applied health researchers who are at the forefront of the field to deliver translational research with impact for our patients. LTHT, the University and CRUK have developed an electronic clinical informatics platform (Patient Pathway Manager, PPM), initially in oncology, now being implemented across LTHT, integrating clinical data with clinical trials information and research outputs including genomic data from the CRUK Stratified Medicine Programme. PPM has delivered important population based outcome measures and will be a valuable tool in taking forward our strategy. A partnership with TPP and systmOne (http://www.tpp-uk.com/latest-news-stories/tpp-launches-researchone/) has driven a combined health informatics initiative with LTHT and pump-primed a recent highly successful MRC Biomedical Informatics programme (PI **Markham**).

Research groupings:

Musculoskeletal Research (27 researchers): In the REF period, we published > 500 papers in peer-reviewed journals, leveraged over £**26**M in external funding (NIHR Leeds Musculoskeletal BRU, NIHR and Arthritis Research UK programme grants, major awards from MRC, Wellcome Trust, NIHR HTA, NEAT and i4i programmes and 5 EU FP7 programmes), have supervised some

69 PGRs (31 current) with 36 degrees awarded, and funded 22 clinical fellows. We are delivering to the research strategy through sustainable research along the whole scientific /translational pathway that translates rapidly to people with inflammatory and degenerative arthritides and other chronic disabling conditions, such as vasculitis and the connective tissue disorders. In the ***inflammatory arthritides*** (total funding £15.7M), **Emery** continues to use detailed clinical phenotyping and early intensive therapy to suppress inflammation and induce clinical remission to achieve relevant patient outcomes, e.g. prevention of structural damage and remaining in employment. Leeds was central in developing novel outcome measures (**Helliwell #1,3,4**; **Tennant #1,2**) and advancing understanding of the use of biologic therapies in all types of inflammatory arthritis. In rheumatoid arthritis (RA), this included proof of concept work exploring the potential of remission induction with TNF-inhibitors, abatacept and rituximab (**Buch #1,2; Conaghan #4; Dass #1; Mackie #1; Ponchel #2; Saleem #1,2; Vital #1**) and phase III, international, multi-centre RCTs (**Emery #1,2,3,4**). Parallel programmes (genetic, genomic, epigenetic, immunological and biomarker discovery) continue to identify key pathogenic processes that have the potential to be translated into the clinic in diagnostic or therapeutic stratification algorithms or as novel drug targets (**Baboolal #1; Dass #2; Helliwell #2 McDermott #2; Morgan #1,2,3,4; Ponchel #1,2,3,4; Robinson #1**). In the ***degenerative arthritides*** (total funding £1.5M) we developed an expanding programme of work with allied health professionals (returned in A3) around osteoarthritis (OA) and common musculoskeletal disorders, such as shoulder pain, based on clinical needs and robust health economic analyses (**Conaghan #1,2**). ***Musculoskeletal imaging*** (total funding £3.3M) continues to be a strength in Leeds, with both MRI and ultrasonography adding value to all areas of our research including diagnosis, monitoring, pathogenesis and therapeutic studies across a wide range of inflammatory and degenerative diseases (**Bennett #1,2**, **Conaghan #3,4; Freeston #1; Grainger #1,2; McGonagle #1,2,3,4; Marzo-Ortega #1,2; O'Connor #1,2; Tan #1,2,3,4; Wakefield #1,2,3,4;**). The ***tissue regeneration and repair*** group (total funding £2M) was the first to prospectively purify mesenchymal stem cells (MSCs) from human bone marrow, a technology now adopted by industry on both R&D and commercial scales (e.g. Miltenyi Biotech). Understanding MSC repair capabilities in different pathological states is essential for determining their future therapeutic potential (**Jones #1,2,3,4**). We are also developing new scientific areas and collaborations across clinical medicine, most notably dermatology (**Wittmann #1,2,3,4**), immunology (**Savic #1,2**) and endocrinology (**Stewart #4**), and have consolidated our research programme in ***rare autoinflammatory diseases*** (total funding £1M: **McDermott #1,3,4; Savic #1**). Our translational strategy now extends to ***connective tissue disorders***, especially scleroderma and vasculitis (total funding £3.8M), with publications across the whole translational pathway (**Baboolal #1, Buch #3,4; Dass #2; Del Galdo # 1,2,3,4; Mackie #2; Tennant #1; Wittmann #2.)**

Cardiovascular Research (17 researchers): Since 2008, cardiovascular researchers within this UoA at Leeds have been awarded total grants of £30M from sources including MRC, the Wellcome Trust, BHF, EU FP, NIHR, Sir Jules Thorn Trust and industrial funders. Our researchers have published > 500 original publications in international journals and have supervised 63 PGR's (32 current) with 41 degrees awarded. We have developed and implemented our strategy, with external review, through our Multidisciplinary Cardiovascular Research Centre (MCRC; www.cardiovascular.leeds.ac.uk; Lead, **Beech**, FMedSci) that spans several UoAs. MCRC's ambitious aims are to discover the causes of, and novel treatments for, cardiovascular disease focussing on mechanisms underpinning cardiovascular complications of type 2 diabetes mellitus and developing novel approaches to enhancing vascular repair. MCRC delivers cardiovascular research across disciplinary and organisational boundaries, including colleagues within LTHT (e.g. **Blackman**). Research spans studies in single cells, to gene modified models of human disease, to studies in humans and longitudinal intervention studies in patients. Atherothrombosis and Diabetes (Lead, **Grant**), Endothelial Cell Biology and Diabetes (Lead, **Kearney**), Cardiovascular Drug Discovery and Development (Lead, **Beech**) and Cardiovascular Imaging (Lead, **Plein**), span discovery science (e.g. ion channel activation by secreted redox protein (**Beech, #4**), clinical science (e.g. **Greenwood, #1,2; Blackman, #1**), to diagnostics (e.g. demonstrating the diagnostic accuracy of cardiac magnetic resonance imaging in suspected angina (**Greenwood, #2**), novel urinary biomarkers in patients with adrenal nodules/hypertension (**Stewart #3**). Our researchers work together to deliver high quality research as evidenced by a BHF Chair award (**Kearney**), ERC Advanced Grant (**Stewart** FMedSci), 3 BHF Programme grants, a BHF special project grant, a

Wellcome Trust Programme grant, 2 MRC DPS awards and an EME award in this REF cycle. Leeds is one of the highest recruiting centres to NIHR portfolio cardiovascular studies;. We have a thriving stream of young clinical academics that will develop further with the newly established Cardiovascular BSc programme. In the last 4 years we have been awarded 10 BHF Clinical Research fellowships, a BHF Senior Clinical research fellowship (**Plein**), a BHF Intermediate Clinical Research Fellowship (**Cubbon**) and an ERC Consolidator award (**Wheatcroft**). Each of our 4 MCRC research groups have published work with accompanying editorials: Atherothrombosis and diabetes (*Blood, ATVB*), Endothelial cell biology and diabetes (*Diabetes, Diabetes Care, ATVB*), Cardiovascular drug discovery *(Circulation Research, ATVB, Nature),* Cardiovascular Imaging (*Lancet, JACC, Circulation)*.

Cancer & Pathology Research: (50 researchers): Researchers at Leeds have been awarded total grant income of over £52M since 2008; major funders include MRC, CRUK, NIHR, EU FP, Leukaemia and Lymphoma Research, NIH, Yorkshire Cancer Research, AICR, Marie Curie, ERC Advanced Grant (**Selby**FMedSci) and Candlelighters, reflecting externally recognised strengths. Over the REF period we have held 6 CRUK programme grants and 3 CRUK Senior Clinical Fellowships. **Cancer & Pathology research** in Leeds is conducted under the umbrella of the CRUK Centre (crossing A 1 & 2), led by **Bishop** FMedSci funded by a £9.75M award from CRUK in 2008. The grouping has collectively published >1200 papers in internationally peer reviewed journals in the REF period (>120 papers in journals with IF >13 in the last 4 years) and supervised 85 PGR's (35 current) with 58 degrees awarded. The Centre has had 4 themes: Cancer Genetics (Lead, **Knowles**), Surgery/Molecular Pathology and Biomarkers (Lead, **Banks**), Targeted Therapies (Lead, **Melcher**) and Clinical Trials (Lead, **Twelves**). Integration of research across these themes is facilitated by their co-location within LTHT, including the National Cancer Research Network (NCRN; Director, **Seymour**).

In ***Cancer Genetics*** the University/LTHT Genomics Facility offers a wide range of state-of-the-art analyses including next generation sequencing and we have developed bioinformatic pipelines applied to many tumour types and single cells. In melanoma, genome-wide association studies identified specific genetic loci aligning with known melanoma risk factors (**Bishop, #1**; CRUK Programme £3.5M) and showed that circulating vitamin D levels at diagnosis influence outcomes (**Newton-Bishop, #1,3**). We established the YCR Centre for Pre-Cancer Genomics and investigated the genomic progression from non-invasive to invasive phenotype for upper aero-digestive tract cancers and developed computational methodology resulting in collaborations locally and internationally (**Rabbitts** FMedSci**, #4**; YCR Programme £2.4M). Recent studies in bladder cancer have defined the signature of a sub-group with a high frequency of metastatic progression that may influence clinical decision making (**Knowles, #1**, CRUK Programme £2.4M) and we demonstrated the role of BLIMP1 in B cell malignancies (**Tooze, #1;** MRC Clinician Scientist Fellowship £1.5M). Work in ***Molecular Pathology and Biomarkers*** exemplifies the A1 strategy and has delivered improvements in cancer patient outcomes by translating advances in basic science into clinical practice through clinical trials especially in colorectal cancer (e.g. case study 4). Rectal cancer outcomes have improved as a result of changes in surgical techniques (**Quirke, #1;** YCR Programme £1.2M) and is underpinned by a strong gastrointestinal/ surgical/ outcomes team (**Hull** ex MRC Senior Clinical Fellow, **Jayne** NIHR Professor; Lead, **Hughes, Hopkins** [supported by US National Institutes of Health]). Retrospective and prospective molecular testing in major MRC- and NCRI-funded clinical trials (**Richman, West, Quirke, Seymour**) has led to the first major stratified medicine bowel cancer trial. We have molecular pathology activities in upper gastrointestinal cancer (**Grabsch, #1**) and breast (**Hanby, #3; Speirs, #1,2**) cancer trials. We have made substantial contributions to the identification/validation of biomarkers in renal (**Banks**, CRUK Programme, £2.85M) and colorectal cancer, and shown *BRAF* and *KRAS* mutations to be predictive of recurrence and sensitivity to chemotherapy in stage 2 colorectal cancer (**Seymour, #1**). Our work in ***Targeted Therapies*** has focused on viral cancer immunotherapy and neuro-oncology. In viral/immune therapies our research is in strategic partnership with the Mayo Clinic, where their strengths in complex pre-clinical models are complemented by our clinical and translational studies (**Melcher**, Cancer Research UK Programme £1.4M; **Vile, #1**). We showed that reovirus stimulates an anti-tumour immune response and can be delivered systemically to liver metastases (**Melcher, #1,4**). We also showed that cDNA libraries expressed in viral backbones can stimulate anti-tumour immunity and help

identify new tumour antigens (**Melcher, #3,4**). Neuro-oncology is an emerging strength, with a CRUK Clinician Scientist Fellow (Short; £600k) leading 3 new laboratory groups, 2 headed by STRFs. We have identified novel molecular targets in brain tumour stem cells (**Wurdak, #3**), demonstrated the importance of tumour cell integrins in the establishment of brain metastases from breast cancer (**Lorger, #1**) and are working with the MCCB Technology Group to generate probes to investigate biological mechanisms in viral-induced hepatocellular carcinoma (**Griffin**). This is complemented by target validation by the BioScreening Technology Group including probes targeting wild-type/mutant FGFR3 binding and phosphorylated FGFR3 (**Knowles**), and the Bioinformatics Technology Group (A5) dissecting molecular pathways in brain tumourigenesis. ***Clinical Trials:*** We have a portfolio of practice changing clinical trials of biotherapies, small molecules, radiotherapy and surgery. Infrastructure support provided in part through our NIHR/CRUK ECMC (**Twelves**, £2M) supports early clinical trials (**Twelves, #3**; **Anthoney, #2**) conducted in collaboration with the pharmaceutical industry, Cancer Research UK and as academic "proof-of-principle" targeted therapy studies (**Melcher, #4**). In later stage trials, we work with the National Cancer Research Network and the pharmaceutical industry to deliver a cancer portfolio of increasing size, breadth and quality (£20M since 2008, of which £9.7M from industry). We led the trial defining the role of chemo-radiotherapy in rectal cancer (**Sebag-Montefiore, Quirke,** CS5) and of chemotherapy in colon cancer (**Seymour,** #**2** and CS4). In haematology, we have made major contributions to paroxysmal nocturnal haemaglobinuria (**Hillmen, #1**; case study 10), myeloid malignancies (**Bowen, #2**), myeloma (**Gordon Cook, #4** and CS6) and paediatric leukaemias (**Kinsey, #1,2**). Several of these trials have been co-ordinated by the Leeds CTRU (A2), which is the Myeloma UK Phase I Co-ordinating Centre. We also made important contributions to studies in the classification of Non-Hodgkin's Lymphoma (**MacLennan, #4**). Other practice changing contributions include the development of eribulin in breast cancer (**Twelves**, **Perren**; CS2), chemotherapy for hepatobiliary cancer (**Anthoney, #2**), bevacizumab in ovarian cancer (**Perren**, #**3**). **Velikova** (CRUK Programme, £4M) has an NIHR Programme (£2.6M) to study patient reported outcomes in clinical practice and trials. In line with our new strategy we are prioritising new developments though recent Academic Leadership Chair appointments in radiotherapy (**Sebag-Montefiore**) and haematology (**Hillmen**); in a short time our translational neuro-oncology team (**Lorger and Wurdak**) has become the largest in the UK. Strength in translational cancer prevention research is built on established links with our ECMC for MRC- and NIHR-funded biomarker studies (**Hull**) and several NIHR programmes (e.g. **Jayne)**. LTHT conducted the second highest number of research studies nationally recognised by the NIHR Clinical Research Network in 12/13.

Genes & Development (16 researchers) is underpinned by long standing expertise in molecular medicine that has largely focussed on the elucidation of mechanisms of rare diseases e.g. ciliopathies (**Johnson, #2,3**), retinal disease (**Toomes, #1,2**) developmental disorders (**Bonthron, #3,4; Sheridan, #1,2,3,4**), malignant hyperthermia (**Hopkins, #3**), and novel genomic methodologies (**Carr, #1; Markham, #2**) Since 2008, this cross-cutting theme has published over 700 papers in international peer-reviewed journals and co-supervised 70 PGR's (28 current) with 66 degrees awarded. The vitality and sustainability of the grouping has been enhanced through funding at Programme grant level or equivalent: the Sir Jules Thorn Trust award (£1.1 M, led by **Johnson)**; MRC funding (**Picton,** £1.4M since 2008); EU FP7 Training Network (**Toomes,** £2.5M). Clinical Genetics is a longstanding distinctive strength based on the abundance of clinical material for study of monogenic disorders (**Bonthron, #1**; **Sheridan, #2**; **Johnson, #1**). Achievements are exemplified by findings that impact on paradigms of disease understanding including the pathogenesis of clubbing and hypertrophic osteoarthropathy (**Bonthron, #1**) and glaucoma (**Ali, #1,2**), as well as findings that have the potential to impact on diagnosis or management of hereditary neurological disorders (**Sheridan, #2** and CS8) and infertility (**Picton, #1,2**).

Strategy going forward: As a top 10 UK University geographically and functionally aligned to the second largest NHS trust in the UK, and new leadership across both University (**Stewart,** Dean; Langlands, VC) and LTHT (Smye, Research Director; Oade, Medical Director; Hartley, CEO; Pollard, Chair), Medicine at Leeds will deliver its vision to be an internationally renowned Biomedical Centre. The School of Medicine strategy outlined above is aligned with that of LTHT; in moving forward the emphasis will be on operation and delivery through key performance indicators. **Markham** FMedSci has been appointed as School Director of Research and new

resource allocation models across the Medical School will target funding to areas of research excellence in Musculoskeletal, Cardiovascular, Cancer and Genes & Development research as its priority areas of strength, whilst simultaneously capacity building in core technologies/ cross cutting activities including imaging, pathology, clinical trials, genetics and informatics. Building on in house expertise (**Stewart, Quirke, Selby**), a renewed emphasis on training tomorrow's clinical and non-clinical research leaders will drive a balanced approach of "nurture from within" and external recruitment. Our strategy provides a clear focus on translational research across the priority disciplines. Innovation will be embedded in all that we do; we believe that development and evaluation of the efficacy of novel therapeutic strategies needs to be focussed in a strong basic science foundation, particularly where the phenotype is evolving and the specificity and predictive capacity of each are changing. Our aims are to 1) Integrate (intellectually and physically), our leading discovery science in biomedicine with clinical translational research. 2) Exploit the unique strengths of Leeds in physical/engineering science notably around cardiovascular and musculoskeletal repair and regeneration. 3) Increase synergistic collaboration across the University and with LTHT, with additional BRU's, BRC and AHSC status in our sights. 4) Focus on areas of international-level research excellence with clear leadership and articulate our strategy and strengths to external parties. 4) Diversify and increase our research portfolio funding (with the aim of matching current ranking 6th in UK on AMRC/ Charitable support QR funding across all sources – RCUK, NIHR, EU). 5) Outwardly engage with industry/ biotechnology partners to drive wealth creation locally and within the AHSN.

In **Musculoskeletal Research** we will pursue a stratified approach, identifying individually targeted, cost effective treatments for patients with both inflammatory and degenerative diseases to deliver improved, validated patient-based outcomes through accurate phenotyping (imaging, cellular, molecular, genetic and soluble biomarkers) and early intervention. In **Cardiovascular Research** we have an ambitious aim to discover the causes of, and novel treatments for, the cardiovascular complications of type 2 diabetes mellitus and to develop novel approaches to enhance vascular repair, underpinned by further investment in our imaging capability. In both **Musculoskeletal** and **Cardiovascular Research** we will work with our iMBE colleagues to focus on use of acellular biological scaffolds and minimally manipulated autologous stem cells as devices for tissue regeneration and repair. Our future strategy in **Cancer & Pathology Research** emphasizes translational genomics (including molecular pathology), and viruses and immune therapy with an emerging focus on radiation biology and therapeutics. We will develop further our existing strengths in colorectal, haematologic, urologic, brain malignancies and melanoma. These activities will continue to be underpinned by a patient-focused research infrastructure including sample processing/banking and clinical trials. Our on-going strategic goal in **Genes & Development** is to utilise research excellence in molecular medicine, genomics, cell biology and animal models of disease, aligned with clinical studies, in specific clinical areas including inherited disease, infection & immunity and reproductive medicine to impact on clinical practice (mechanisms, novel therapies) and subsequent health outcomes.

a. **People, including (i) Staffing strategy and staff development:**

To deliver our strategy in translational research based upon convergent strengths in biomedical, applied health and clinical science, it is essential that our staffing structures reflect a true integration of clinical and professional science staff. Integration is evidenced at every level with clinical academics both leading and working alongside biomedical and applied health scientists to frame and articulate clinical questions in our multidisciplinary research groupings. We have an on-going commitment to equality of opportunity across the UoA and within the University as a whole. The School of Medicine obtained Athena Bronze status in October 2013 and is on track for silver submission in 2014; the Faculty of Medicine and Health made funding available for those returning to work (the "STAR" scheme) after maternity, carer or longer term sick leave to pump prime their research.

Sustainability and Support for researcher career development: We are addressing the needs for sustainability in translational research by 1) Strategic investment in Academic Leadership Chairs; 2) Strategic investment in appointment of key professional scientists to Senior Translational Research Fellowships (STRFs); 3) University-wide and A1-specific career development initiatives for Early Career Researchers; 4) Development of a Leeds-based cohort network and programme

for NIHR Academic Trainees: Academic Clinical Fellows (ACF), Academic Clinical Lecturers (ACL) and Clinician Scientists (CS) that directly links to undergraduate academic initiatives (intercalation, INSPIRE, LURE fellowships) and 5) Alignment of strategic priorities with LTHT permitting close working to agreed objectives with NHS clinicians. The introduction of a new Associate Professor grade by the University in 2011 has allowed the launch of an innovative Honorary appointment scheme for LTHT consultants with protected time for academic activity, most of whom are research active; several are returned in A1 and A2. The close working relationship between academic staff within A1 and LTHT NHS clinicians is further exemplified by the number of existing Honorary academic appointments to support both research and student education (73 current visiting contracts).

As part of a £23M investment programme, the University of Leeds has supported the appointment of **Academic Leadership Chairs** aligned with our research strategy. Within A1, an Academic Leadership Chair was appointed in Experimental Haematology (**Hillmen**) with a second Chair in Haematology and support for other academic appointments from LTHT. Two Professors of Clinical Oncology were appointed in 2012 to develop radiotherapy research (led by **Sebag-Montefiore**). Appointees to new Leadership roles are supported by senior mentors and via participation in University–wide Leadership programmes and a Leadership Forum that promotes collective sharing of strategic intelligence and input into proposed University level initiatives. Significant additional resource has been unlocked for the new Dean for recruitment in areas of excellence.

The **STRF scheme** is distinctive to Leeds, designed to support and sustain our translational research agenda. Each was awarded a 5y post, with challenging targets but developing towards tenured positions. The STRFs have been key in drawing together interdisciplinary working across our A1 Research groupings including appointments in **Musculoskeletal Research** (Musculoskeletal Biotherapy); in **Cardiovascular Research** (Medicinal Chemistry linked to Cardiovascular Disease, Cardiac and Vascular Tissue Engineering); in **Cancer and Pathology Research** (Cancer Angiogenesis, Antivirals and Viral Oncology, Targeted Cancer Therapy, Surgical Technologies). Four STRFs are returned within A1 (**Del Galdo, Griffin, Lorger, Wurdak**); the remaining 9 are returned in UoAs 5,8,9,11 and 12, working in areas related to medicine. Each STRF has joint clinical/scientific mentoring and structured interactions with senior scientific colleagues ensure a collective focus on translational research and enhanced levels of collaboration resulting in increased numbers of translational research awards (£2.6M in total research awards to A1 STRFs to date). We invested in Junior Fellowships in 2012, supported by matched funding from the University's Wellcome Trust Institutional Strategic Support fund, bridging the gap between the first postdoctoral position and the award of an externally funded fellowship. This new initiative has resulted in two A1 2y Junior Fellowships (including **Stead**), each provided with £20K start up funding and close mentoring towards obtaining External Fellowship follow-on funding.

Career development for biomedical researchers: As part of the RCUK Concordat, all post-doctoral fellows are supported through the School-Institute structures and are allocated a research mentor. Support includes access to in-house courses, training and career workshops organised by the University's Staff and Department Development Unit), Faculty-based discipline-specific training, and development of transferable skills. The Leeds **Next Generation Researcher** programme has been developed in line with the Concordat to support the Career Development of Researchers and the national Researcher Development Framework (RDF). **Faculty training hubs** provide training and development for research students and junior research staff at cognate discipline level. Enhanced support for Fellowship applications was introduced in 2011. Funder-specific workshops, including representation from the funding bodies (MRC, Wellcome Trust, NIHR, EPSRC) are routinely held and associated surgery sessions with funders and researchers arranged on a 1:1 basis. An **Early Careers Group** was introduced in 2011 to enhance career development for PhD's and PGRs within A1, whether they are interested in a future career in academia, wider research or other related field. Group activities include: Monthly meetings with invited experts from across the University providing information on career development, development of a pilot grant award for early career staff, 'research idea' away days, multi-disciplinary research meetings to encourage interdisciplinary research collaborations and help with applications through "grant clinics". Twenty-one ECRs are returned in this submission. Career development for our basic scientists is highlighted by our success in competitive externally-funded Fellowships at Foundation/ intermediate level (**Robinson**), Academic Senior Fellowships (**Ponchel** and through HEFCE

support for internal non-clinical Lectureships and Senior Lectureships (**Jones**). At the heart of the development of all of our non-clinical staff is the annual **Staff Review and Development Scheme** (SRDS), providing the opportunity for 2-way review of work progress, identifying key objectives and development needs and aligning these against training opportunities led by head of school with input from Directors of Education and Research. The University monitors its progress in meeting its objectives in researcher training and staff support through participating in Careers in Research Online Survey (CROS) and the Principal Investigators and Research Leaders Surveys (PIRLS).

Career development for clinical researchers and NIHR Academic Trainees: An integrated undergraduate and postgraduate strategy for clinical academic training is overseen by **Quirke** who is also the NHS/NIHR Academic Training Director, ensuring alignment between the needs of academic and NHS pathways. Training is divided into 5 themes: Medicine, Surgery, Pathology, Health Sciences and Education, each overseen by an academic Training Programme Director with input from the post-graduate Dean. The themes are aligned to Academic Foundation posts in these specialties and also to student research societies, jointly managed by the students and the theme leads, allowing recruitment of the brightest students into our academic streams. Academic trainees are actively managed through both individual mentorship and as cohorts especially at the PhD-Clinical Lecturer and Lecturer-Clinician Scientist boundaries. Research education workshops focussed on medical academic skills and enhancing career progression are held biannually, augmenting the University research skills courses. Training in research methods is delivered through formal certificate, diploma and MSc courses. The success of the integrated approach is evidenced in the numbers of our NIHR funded ACFs and ACLs, which have grown year on year to 20 new awarded posts for 2013. Thirty three NIHR academic trainees (ACFs, ACLs and CS) were in post in 2013, forming the West Yorkshire Academic Clinical Trainee (WYRACT) network that meets quarterly. During this REF period, 8 A1 trainees have progressed to permanent academic positions or Clinician Scientist Fellowships of whom 5 are returned here (**Buch, Tan, Freeston, Mackie, Vasudev**). We continue to work across the new Local Education and Training Board with the PG Dean to expand Clinical Lecturer numbers in our areas of greatest strength, matched with HEFCE funds (£700K for 6 new clinical lecturer posts secured in October 2013).

Processes for support of research work: Costing and pricing of external awards is facilitated by the Faculty's Research Office team (13 FTE) providing a dedicated service for researchers in the Faculty of Medicine and Health. Institute–based Research Administrators provide support in building relationships with key funders, advising researchers in all aspects of the research award process, liaising with colleagues in the NHS R&D offices, horizon scanning for funding opportunities and facilitating development of cross-Faculty and cross-organisational bids. University research innovation staff and HEIF directed support posts assist all staff in supporting industry partnership funding streams.

ii) Postgraduate Research Students (PGRs): We value PGRs as our earliest career stage researchers, their integration into the scientific life of our research groups bringing additional vibrancy to the community. We recognise that the first step towards developing a first-class research training programme is the PGR student experience, and are committed to promoting an environment that empowers students to reach their full potential. Excellence in PGRs is fostered through our state-of-the-art infrastructure, supervision by international leaders, access to innovative teaching and development of generic transferable skills to enable future employment and success in chosen career objectives. Our national MRC Doctoral Training Grant PGR allocation (3/year) is shared with Biological Sciences (A5). Over the REF period 201 FTE doctoral degrees have been awarded (59% PhD, 40% MD and 1% DClinPsychol). Of those graduating, 32% went onto academic posts, 46% into clinical positions, 15% onto further education; 7% of our PhDs went into industry.

Student support & Facilities: Co-ordinated within the Graduate School, and in keeping with our multidisciplinary strategic approach, all students have 2 or more supervisors who have completed the University's formal training course in student supervision. All PGRs agree a training plan with their supervisors within one month of starting their programme; progress is monitored with regular documented meetings and the plan adapted in response to PGR and project needs in real-time. Training, progress and assigned supervision meetings are recorded using the University's Postgraduate Development Record System (PDRS), based on the national Researcher Development Framework. All students are allocated a personal postgraduate research tutor who

provides pastoral and measured guidance, to share best practice and support each PGR. PGRs are encouraged to attend, and participate in, national and international conferences, showcasing their work, developing contacts and communication skills; each student is awarded £1K/year to attend such meetings. They also participate in bi-annual Faculty PGR symposia and University-wide conferences to promote and develop their academic and communication skills. Our PGRs also organise their own monthly seminar series ("PG Tips") as part of a peer-support network. PGRs have access to courses through the University Graduate Training and Support Centre in line with the Vitae Researcher Development Framework to develop world-class researchers and build the UK higher education research base and workforce. Our PGRs have indicated a very high level of satisfaction with the facilities, supervision, training and professional development opportunities within the School through the Postgraduate Research Experience Survey (PRES) 2013.

b. **Income, infrastructure and facilities:**

Research Income:

A shared aim across A1 has been to work in strategic partnership with the beneficiaries and funders of our research to increase research income for translational research. Our success is exemplified by our hosting of NIHR Organisations including NIHR IS (Information Systems), INVOLVE (Patient and Public Involvement in Research), CCRN CC (Clinical Research Networks Co-ordinating Centre) and NCRN CC (National Cancer Networks Co-ordinating Centre) and is reflected in our funding portfolio. Establishment of the NIHR CCRN (budget £249m) was underpinned by research at Leeds (**Selby**, CS 9) that led to the configuration of the Cancer Networks, Centre and Units. The CCRN, together with the Topic-specific and Primary Care Research Networks, has achieved unparalleled levels of research participation and activity nationally (637,984 patients recruited in 12/13 into a portfolio of > 3000 research studies).

Cancer clinical researchers are extensively involved in the NCRN CC (income £95M over the REF period)**,** which is led from Leeds (**Seymour**) under the auspices of the National Cancer Research Institute (NCRI). The NCRN is developing new trials in rarer cancers world-wide through the International Rare Cancers Initiative (**Seymour**). Likewise, the NCRN screening, prevention and early diagnosis initiative has been launched in collaboration with the Primary Care Research Network (**Seymour**). The scale of NCRN activities is exemplified by the 87,806 participants in cancer research studies in 2011/12, equivalent to 23% of all incident cancer cases. The NCRN delivers high proportions of studies to time and target in both the commercial (68%) and academic (75%) portfolios. Local participation in the NCRN adopted commercial portfolio also increased by more than 50% from 2010-11, with 2,342 participants.

Infrastructure and facilities: The infrastructure and facilities needed to support A1 research have been developed both within the clinical areas and the basic science laboratories. The infrastructure reflects the specialist needs of the relevant research grouping but all research facilities operate on an open access basis, avoiding unnecessary duplication of specialist facilities. Laboratory facilities for **Musculoskeletal, Cancer & Pathology** and **Genes & Development Research** are co-localised within the Wellcome Trust Brenner Building, a purpose built suite of laboratories sharing infrastructure, expertise and equipment across organisational boundaries, and the Clinical Sciences Building . This promotes the interdisciplinary working that is central to our research strategy and provides opportunities for targeted capital equipment investment. A Director of Laboratories has responsibility for co-ordination of core laboratory provision, research facilities, and capital equipment renewal and replacement, resulting in an integrated approach to management of the extensive equipment base, costing and charging of facilities, better provision of laboratory infrastructure and a co-ordinated approach to equipment renewal and planning. As a result researchers (including PGRs) have access to state-of-the-art facilities including Biomedical Services, Biacore, RT PCR, Next Generation Sequencing (NGS), genomics, proteomics, flow cytometry, imaging, histology, siRNA screening and Bioinformatics. The high health, SPF barrier facility in the biomedical services facility is exceptional within the UK; experimental equipment includes a Vevo770 micro-ultrasound and IVIS fluorescent imager with an image-guided small animal irradiation system being installed in 2014. The NGS facility accommodates 2 new next generation sequencers including the high capacity HiSeq, library maker and substantial IT infrastructure. **Cancer & Pathology** imaging and radiotherapy research infrastructure includes 2 PET-CT scanners (1 NIHR-funded) and 2 dedicated research linear accelerators (Elekta) with

funded research physics and clinical imaging expertise, and novel digital pathology technologies. **Musculoskeletal** has embedded imaging facilities. LMBRU provides on-site sample biobanking combined with a web-based information management system, allowing translational research to be embedded within routine clinical practice. LMBRU's Imaging Centre includes a NIHR-funded 3T Siemens Verio with additional imaging technology, including a 4-D fusion machine, supported by Arthritis Research UK. The Centre has 2 dedicated ultrasound rooms housing GE9 and Voluson-i ultrasound. **Cardiovascular** research is based within the LIGHT laboratories, providing high quality dedicated laboratory infrastructure and facilities together with open plan office accommodation. The new MRI clinical imaging facility (3T, Philips, funded by BHF), is housed in the LGI, which is adjacent. Facilities in LIGHT are shared with the Faculty of Biological Sciences (A5) reflecting the close working relationship between cardiovascular researchers across MCRC.

Evidence of cross-University shared/collaborative equipment/infrastructure & benefits in kind: Capital equipment planning across Clinical Medicine is undertaken annually and plans are considered to ensure strategic alignment and avoidance of duplication. This strategic approach ensures best use of resources, placed in their best academic 'homes', on an open access policy in order to maximise use of the investment. Following the Wakeham review, and in response to RCUK requirements, Leeds developed a sector-leading searchable database of capital items. In a large University such as Leeds this has the wider outcome of providing a mechanism through which resources – both within the University and further afield (e.g. this is now being used by the N8 Universities group). Our NGS facility, used across A1 Research groupings, results from collaboration between LTHT and the University, with joint equipment purchases and shared running costs, reflecting the close working relationship between our researchers in **Genes & Development** and the end users of that research in clinical genetics. In **Cancer & Pathology Research**, we established a Sample Processing Facility (**Banks**) for tissue collection that has generated a HTA Licensed Research Tissue Bank of over 3000 frozen samples; the facility also supports clinical trials and commercial partnerships. Leeds also hosts the Breast Cancer Campaign (**Hanby**, **Speirs**) and Non-Hodgkin's Lymphoma (**MacLennan**) tissue banks and a CRUK funded bank of patients at high risk of developing lung cancer (**Rabbitts**); we are contributors to Phases 1 and 2 of the CRUK Stratified Medicine Programme. ECMC funding has provided key infrastructure for the development of imaging mass spectrometry within proteomics-focussed biomarker discovery studies; these activities are now being subsumed into focussed proteomics-based programmes as well as providing a facility for use by collaborators. In addition to the co-funded NGS, the proteomics facility (used by **Cancer & Pathology**, **Musculoskeletal** and **Genes & Development** teams) has 3 mass spectrometers with liquid chromatography and robotics systems. The QSTAR mass spectrometer was 50% donated by AstraZeneca as part of a collaborative research initiative while the AutoFlex III mass spectrometer was purchased through LTHT. The flow cytometry facility includes 2 FACs analysers also donated by LTHT Charitable Trust.

Policy and practice in research governance: We believe we have a duty of accountability to society, our patients, our professions, the Institution and the funders of our research to accept full responsibility for the ethical integrity of our work. The Faculty of Medicine and Health provides central support to ensure and assure these values in compliance with the University's policy on ethics, the NHS framework for ethical research and the legislative requirements of the Human Tissue Act. The Head of Faculty Research Support manages a Quality Assurance team, jointly funded with LTHT, who provide a source of support, advice and QA for trials activities within the Faculty but predominantly within A1 and A2. To support compliance with the Human Tissue Act, the University introduced the "Achiever" software system to document and track all samples covered by the Act.

c. Collaboration and contribution to the discipline or research base during REF period

We recognise the strategic importance of regional, national and international collaborations in addressing global health challenges, and support and encourage our staff to participate in such activities.Examples include stronger collaborative links with Sheffield (Cancer), the hosting of EU collaborative platforms in Leeds, use of endowments to fund academic placements in overseas Institutions, the newly designed Leeds-Crick Clinician Scientist scheme and participation in the Northern Health Science Alliance.

Interdisciplinary collaborations are key to our A1 strategy to deliver translational research against defined clinical challenges. Researchers in **Musculoskeletal** and **Cardiovascular** research are co-investigators in the £11.2M Wellcome Trust-EPSRC funded Centre that brings together >200 engineering, physical science, life science and medical researchers from the University of Leeds and LTHT with clinicians and industrialists to deliver a series of clinical innovations focused on improving the quality of life for older people with musculoskeletal and cardiovascular disease. These include development of longer lasting joint replacements in the hip, knee and spine; novel regenerative biological scaffolds for degenerative tissues; advances in cell therapies using a patient's own stem cells; advanced medical imaging to help earlier diagnosis and intervention; and novel protein biosensors for disease diagnosis and improved patient targeting. WELMEC is further advanced via the EPSRC-TSB Innovation Knowledge Centre for Medical Technologies. **Musculoskeletal Research** includes national and international collaborations across the Wellcome Trust Case Control Consortium (**Emery, Marzo-Ortega, Morgan**), the UK RA Genetics Group (**Morgan**), Biologics in RA Genetics and Genomics Study Syndicate (**Morgan)**, International Genetics of Ankylosing Spondylitis Consortium, national Psoriatic Arthritis Consortium (**Helliwell, Marzo-Ortega, Morgan**) and the international Pharmacogenomics of Methotrexate in RA (PaMeRA) Consortium (**Emery, Morgan**). Other collaborations include the MRC-ABPI Consortium (**Emery, McDermott, Ponchel** and MRC Stratified Medicine Consortium (**Morgan**). **Conaghan/Emery** co-founded the OMERACT- MRI Task Force (23 papers) and the OMERACT-US Task Force was co-founded by **Wakefield/Conaghan** (8 papers). **Conaghan** is working with the University of York Clinical Trials Unit and the ARUK Centre of Excellence in Sports Medicine (Nottingham) while **Ponchel** collaborates with Cranfield University in developing an IL-7 signalling inhibitor. Internationally, **Emery** and **Ponchel** are collaborators with European centres in FP7-funded research (**€2M**) on diagnostic biomarkers and on autoantibody fine mapping. **McDermott** is part of a FP7 **€3.8M award spanning 3 Universities, 4 Hospitals and 2 SMEs**.

External collaborations in **Cardiovascular Research** include BHF Centres of Excellence in Oxford (**Kearney, #1**; **Greenwood, #1**) and Kings College London (**Plein, #3,4**) addressing clinical challenges in diabetes. The grouping also collaborates with investigators in the Cambridge MRC Centre of Metabolism (**Wheatcroft**, **#1**). Cardiovascular disease in association with diabetes is a global challenge and the Group collaborate successfully with Columbia University USA and the University of Pennsylvania USA (**Ajjan**, **#2**). **Stewart** (**#2**) adds Endocrine Hypertension expertise and is a founder member of the EU funded European Adrenal Network (ENS@T).

In **Cancer & Pathology Research, Newton-Bishop** leads the international GenoMEL and newly formed BioGenoMEL Consortia studying the genetics of melanoma. **Banks** plays a central role in the International Cancer Genome Consortium (CAGEKID) EU FP 7 developing genomic biomarkers in renal cancer; this will extend through McGill University to involvement in the International Human Epigenome Consortium. Leeds is also one of only 4 UK centres involved in the US-led DIRECT GWAS study of drug-induced renal injury. **Melcher** & **Selby** have established collaborations in immunologic and biologic cancer therapies with the Mayo Clinic, USA (**Vile**) that complement our translational work. **Hull** has collaborative projects with the Karolinska Institutet (**Hull, #4**) and University of Bologna (**Hull, #2**). **Twelves/Anthoney** have conducted more than 20 early phase cancer clinical trials with commercial partners including Roche, Pfizer, Chugai, Boehringer Ingelheim and Eisai. **Melcher's** collaborators in oncolytic virotherapy include Amgen, Oncolytics, Genelux, Transgene, Virttu Biologics and Viralytics. We collaborate with Elektra evaluating novel radiotherapy techniques (**Sebag-Montefiore**) and have participated in trials via the CRUK Combinations Alliance, investigating novel drug combinations, primarily with Astra Zeneca. We provide extensive tissues for the CRUK Stratified Medicine Programme. In **Genes & Development**, **Bonthron** is part of an FP7 funded project investigating defects in innate immunity. **Bonthron** also has a longstanding collaboration with colleagues in Colorado on the role of fructose in obesity, diabetes, hypertension, and kidney disease. **Sheridan** has a longstanding collaborations with Prof R Houlston (Institute of Cancer Research), Prof Heymut Omran (Munster, Germany), and Prof Robert Kleta (UCL) underpinning his leukaemia and renal studies. **Hopkins** is a co-investigator on a US NIH programme with colleagues at Harvard and Utah on malignant hyperthermia.

Collaborations with external bodies & response to national and international priorities/initiatives: Our shared strategy across A1 has been to work with our partner beneficiaries and funders to

provide a focus for translational science. Each of our A1 research groupings actively contribute to the wider discipline base at national and international levels, reflecting the influence of our researchers. As part of the job planning and annual review process this "Leeds Citizenship" is actively encouraged and supported at every career level and recognised through our promotional procedures.

We have NIHR Senior Investigators in each of musculoskeletal (**Emery**, **Conaghan**), cardiovascular (**Stewart**) and Cancer & Pathology (**Selby**), and the CTRU (Brown, A2); **Jayne** is one of only 18 NIHR Research Professors across the country.

In **Musculoskeletal Research, Emery** was President of the European League Against Rheumatism (2009-2011). **Conaghan** Chairs the Arthritis Research UK Osteoarthritis Clinical Study Group while **Morgan** is Arthritis Research UK Adult Inflammatory Arthritis INBANK Hub Lead. Researchers are members of the NICE Guidelines Development Groups for osteoarthritis (**Conaghan**) and psoriatic arthritis (**Helliwell**), Outcome Measures in Rheumatology (OMERACT: **Conaghan, Tennant**), WHO (**Tennant**) and the EULAR Scientific Committee (**Emery, Conaghan, McGonagle**). **Helliwell** is Vice President for the Group for Research and Assessment of Psoriasis and Psoriatic Arthritis. **Conaghan** and **Morgan** are representative members of grant awarding bodies/ Fellowships committees, including NIHR, HTA EDaPT and Arthritis Research UK. National and international prizes, include: **Emery:** Medipex NHS Medical Innovations Award (2008); Genesis Award 2011, BSR Innovations in Rheumatology Award (2012), Carol Nachman Award (2012), **Helliwell**: outstanding achievement by Society for Chiropodists and Podiatrists (2013); **Coates:** the US Scopus Young Investigator of the Year for Biomedical Sciences (2011). Many staff hold positions on the Editorial Boards of leading journals within the discipline including *BMC Musculoskeletal Disorders* (**Wakefield** Associate Editor).

In **Cardiovascular Research**, Leeds hosts the journal *Diabetes and Vascular Disease Research.* **(Grant)** also leads on the European Society guidelines for cardiovascular disease management. **Beech, Kearney** and **Wheatcroft** have served/serve on the BHF project grants committee, **Beech** is member of the MRC Populations and Physiological Sciences board and Wellcome Trust India Alliance Research Committee. **Kearney** is a member of the BHF Fellowships Committee. **Stewart** chairs the MRC Training and Careers group, is a member of MRC Strategy Board and BHF Trustee. **Beech** and **Kearney** members of the *Circulation Research* and *Diabetes* editorial boards respectively, **Plein** editor of the *European Heart Journal of Cardiovascular Imaging* and Chair of the European Committee on training in Cardiovascular MRI. The International Society of Endocrinology (**Stewart**, Secretary-Treasurer) is hosted at the University of Leeds (http://www.endosociety.com/).

In **Cancer & Pathology Research**, **Selby** is President of the Association of Cancer Physicians (2007-) a member of CRUK Council and Research Strategy; he was awarded the Pfizer Excellence in Oncology Lifetime Achievement Award. **Sebag-Montefiore** is Chair of the CRUK Clinical Trials Advisory and Awards Committee. Melcher sits on the CRUK New Agents Committee, as did **Twelves** who is now on the Grant Review and Monitoring Committee of the Brain Tumour Charity; **Twelves** was Scientific co-Chair of the 2009 European Cancer Conference. **Hull** led identification of UK research priorities in Gastroenterology and Hepatology for NETSCC and chairs the United European Gastro-enterology National Societies Committee.

In **Genes & Development, Wilcox** has both national and international roles in *C. difficile* diagnosis methodology referencing while **Markham** holds key roles with the DoH, including chairing the MHRA Clinical Practice Research Datalink (CPRD) and NIHR Senior Investigator Awards panel, the NIHR Research Capability Programme, the Clinical Outcomes in Cancer Group and the Scientific Strategy Committee of Arthritis Research UK. **Hopkins** is President of the Anaesthetic Research Society and Board Member for the National Institute of Academic Anaesthesia. **Bonthron** is Senior Editor of *Journal of Pathology* and Associate Editor of *Journal of Medical Genetics,* and member of the MRC Molecular & Cellular Medicine Board. **Sheridan** is on the Grant awards committee of Wellbeing of Women.

Engagement with other organisations, our own networking through national and international forums, and the interactions listed above are all vital to the effective dissemination of our research and its translation into patient benefit.