Institution: University of Southampton (UoS)

Unit of Assessment: 01 Clinical Medicine

1. Unit context and structure, research and impact strategy

1.1 Context

The Faculty of Medicine will celebrate its 50th Anniversary in 2022 having made a substantial impact on medical practice across areas of research strength in basic discovery and translational science. Our vision is to lead innovative learning and discovery for better health across the life course; we have invested in multidisciplinary research teams, creative educational programmes, translational research programmes, clinical infrastructure, and enterprise to deliver this vision.

The Faculty employs 412 academic staff including 94 professors, 74 associate professors and 37 Lecturers, of whom 125 are clinical academics. Annual research income is currently £30.9M, having grown by £7.8M (33%) since 2013. In the REF period the Faculty has been awarded, and renewed, its Athena-SWAN Silver award, implemented a Faculty-wide mentoring service and increased the proportion of female and BAME senior academic staff.

The Faculty is led by the Dean, Professor Diana Eccles and is administered via four Schools:

- Cancer Sciences (CS)
- Clinical Experimental Sciences (CES)
- Human Development and Health (HDH)
- Primary Care, Population Sciences and Medical Education (PPM).

Staff returned in UoA1 include members of all four schools, with the primary care group in PPM returned in UoA2 and components of CES (psychiatry, neurology) returned in UoA4.

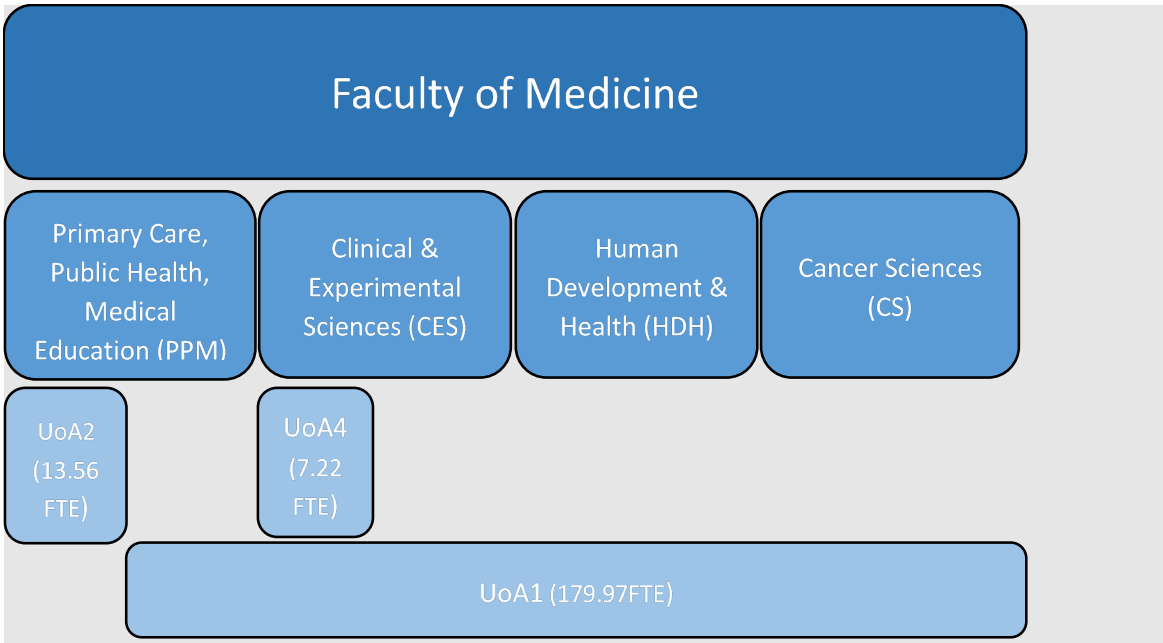

Figure 1: Structure of the Faculty of Medicine: majority returned in UoA1, Primary Care Research Centre returned in UoA2 and psychiatry/neurology in UoA4. Additional staff are returned in UoA3 (3 FTE), UoA5 (2 FTE) and UoA22 (0.6 FTE).

Five Research Centres are fully integrated within the Faculty and its strategy:

- Cancer Research UK (CRUK) Southampton Centre and NIHR CRUK Experimental Cancer Medicine Centre (ECMC)
- Southampton Centre for Biomedical Research incorporating the NIHR Southampton Biomedical Research Centre (BRC) and the NIHR Southampton Clinical Research Facility (CRF)
- NIHR Wessex Applied Research Centre (ARC) hosted by the School of Health Sciences (UoA3)
- MRC Lifecourse Epidemiology University Unit (MRC LEU)
- Versus Arthritis-MRC National Centre of Excellence for Musculoskeletal Health and Work

Three major enterprise units are also central to the Faculty strategy: the Southampton Clinical Trials Unit (SCTU), the Wessex Institute (WI) and the Clinical Informatics Research Unit (CIRU).

Key to the Faculty's research strategy is the University of Southampton/University Hospital Southampton (UoS/UHS) Partnership. This draws strength from the very best of Southampton's basic science research in biomedicine, psychology, social sciences, electronics and computer science and mathematics.

Figure 2: The Southampton translational medicine partnership. Faculty research supported by close integration with both wider UoS and population and experimental medicine/clinical research infrastructure (MRC LEU, Wessex ARC, NIHR SPCR (UoA2), together with University Hospitals Southampton) enabling clinical and population need to inform basic research priorities and rapid translation from bench to bedside.

1.2 Research Strategy

The Faculty vision is to "*Lead innovative learning and discovery for better health across the life course*." The strategy underpinning this vision aims to:

- Foster multidisciplinary, translational research.
- Inspire and equip future generations of scientists and clinicians to meet the challenges of a changing world.
- Promote and lead partnerships and collaborations within the Faculty, across the University, regionally, nationally and globally.
- Push the boundaries of current practice to foster a culture of innovation and enterprise.

Our research has four key approaches:

1. Combining basic mechanistic and clinical research to deliver internationally-leading research and resultant outputs.
2. Early clinical translation, utilising and fostering links with the NHS.
3. Interdisciplinary collaborations, through the UoS Institute for Life Sciences (IfLS).
4. Enterprise and innovation.

This involves a close partnership with UHS, which is governed as outlined in **Figure 3**.

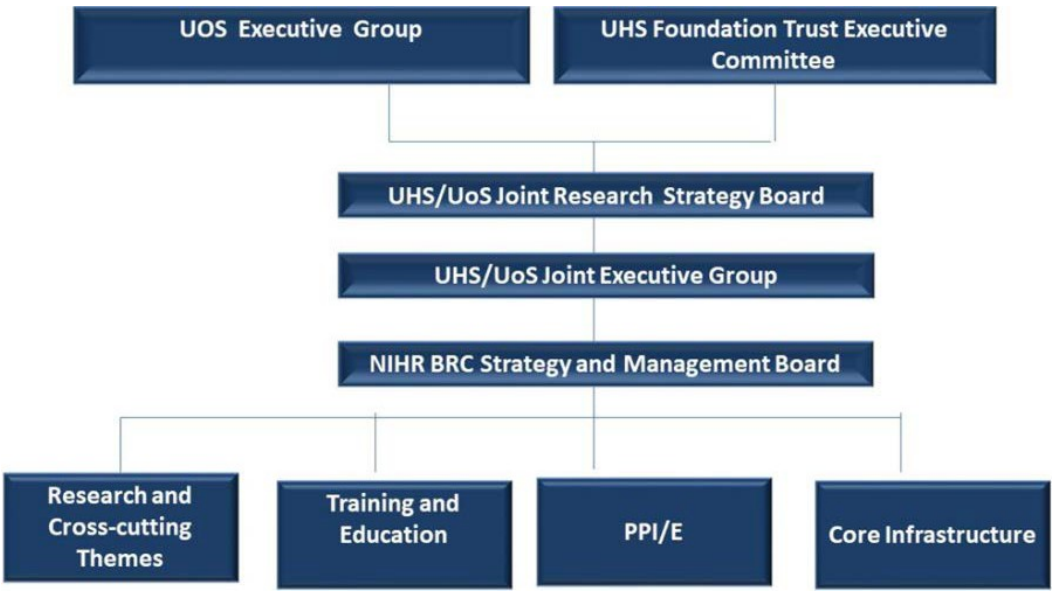

Figure 3: the UoS-UHS partnership supports our research strategy through a joint management structure ensuring alignment of Trust and University research investment and support.

Our research falls within five key themes:

- **Cancer Sciences**
- **Healthy Ageing and Multi-Morbidity**

- **Infection and Microbial Science**
- **Developmental Sciences and Regenerative Medicine**
- **Population Science**

Supporting these themes are five cross-cutting research platforms:

- Cell Biology & Chemistry of Life
- Immunology
- Clinical Trials & Experimental Medicine
- Systems Biology
- Data Science

These methodological platforms underpin the research strengths within the research themes and guide investment in staff and infrastructure (**Figure 4)**.

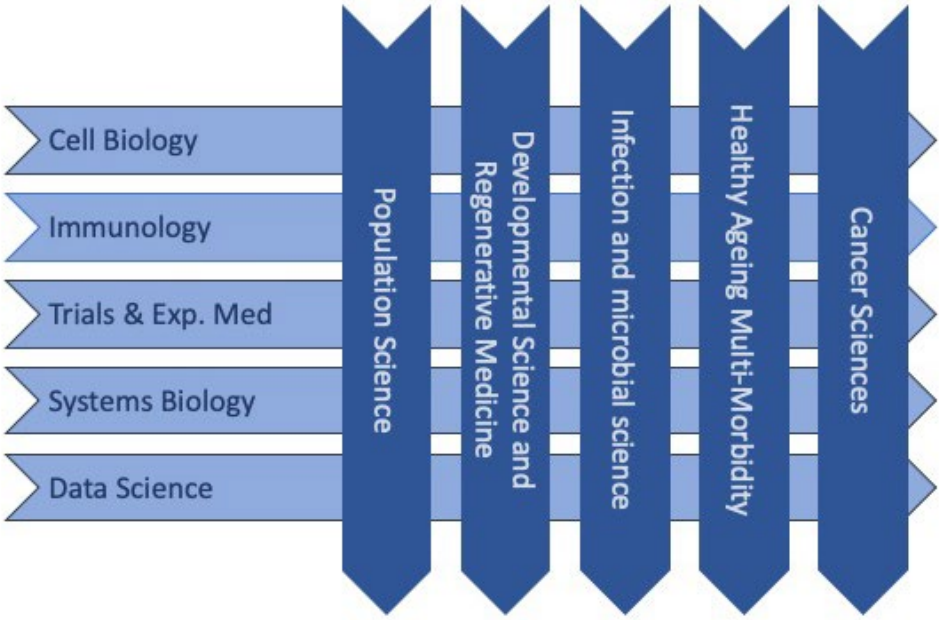

***Figure 4**:* Faculty of Medicine integrated research strategy showing major research themes and methodological platforms.

1.2.1 Cancer Sciences

Research in cancer sciences is supported by a long-established relationship with CRUK. Our facilities include the CRUK Southampton Centre, CRUK ECMC (**A Davies**, **Williams**) and core funding from CRUK to the SCTU (**Griffiths**). Southampton also hosts a Bloodwise centre of excellence in understanding and treating lymphoid malignancies. Co-location within the footprint of the South coast's major tertiary referral cancer hospital delivers unrestricted access to cancer patient-level data and biospecimens. The latter is a key strength, made real by our long-standing investment in surgical oncology and supported by an HTA accredited tissue bank (**Thomas**). In 2018 the Faculty opened the Centre for Cancer Immunology (CCI), a purpose-built facility to expand research capacity and accelerate our translation of immunotherapy to patients, providing dedicated state of the art laboratory facilities to house >200 scientists and support staff, comprising both basic discovery science, preclinical facilities, and clinical teams.

The CRUK Centre has an international reputation and acknowledged opinion leaders in the treatment of lymphoma, immunotherapy, and upper gastrointestinal surgery. The Faculty currently holds 5 CRUK Programme grants (**S Ward & Ober**, **Cragg**, **Packham**, **Glennie**, **Elliot**), two Advanced Clinician Scientist Awards (**Underwood**, **Sean Lim**) and two CRUK Network Accelerator Awards (**Johnson**, **Forconi**) which bring together experts across the UK and internationally. The Centre has significant collaborations with biotech (BioInvent, BioNTech, Epizyme) and pharma (Roche, AstraZeneca, Johnson & Johnson) to support translation into clinical testing from laboratory programmes. Ten novel biotherapeutics have moved from the laboratory programmes of the centre to exploratory clinical studies, either directly or in partnership with biotech companies (ICS01-10 and ICS01-07).

There is a broad interdisciplinary collaboration spanning structural biology, chemistry, glycobiology, microfluidics, immunopeptidomics, mathematics and computing to address the most challenging cancer questions. For example, how to understand the immunopeptidome of solid tumours using mass spectrometry and how to define tumour ecosystems with unique microfluidic solutions.

1.2.2 Healthy Ageing and Multi-Morbidity

The healthy ageing research theme encompasses research groups in Respiratory, Allergy and Critical Care (aligned with the Respiratory and Critical Care theme of the BRC), Musculoskeletal disease (aligned with the MRC LEU), Nutrition (aligned with the Nutrition theme of the BRC), Metabolism, Endocrinology and Cardiovascular Disease, Inflammation and Immunity, and Clinical Neuroscience and Mental Health (UoA4).

Respiratory, Allergy and Critical Care: Southampton is a leading international centre for research in respiratory disease, especially asthma (**Djukanovic**, **Holgate**, **Howarth, Haitchi)**, chronic obstructive pulmonary disease (COPD) (**Wilkinson**), primary ciliary dyskinesia (PCD) (**Lucas**), idiopathic pulmonary fibrosis **(M Jones**), and respiratory infections (**S Clarke, Elkington, Read**; **§1.2.3**). The programme encompasses translational studies in human disease, linking basic and clinical science with strong pharma involvement (**§4.3.2,** ICS01-05**)**. Complementing the clinical research strength is significant expertise in respiratory biology including immunology (**Staples, Sanchez-Elsner**), airway cell biology (**D Davies**, **Swindle, Blume, J Collins, Lackie, Mennella**), mast cells (**Walls**), genomics (**JW Holloway**) and biomarkers (Skip (UoA5)). **Loxham** leads a programme in the respiratory effects of air pollution and **Holgate** is the UK Clean air champion (ICS01-06).

In *allergy* **Arshad, JW Holloway, Kurukulaaratchy, G Roberts** lead the Isle of Wight Birth Cohort investigating epidemiology, natural history, genetic and environmental risk factors in the origins and progression of asthma and allergy spanning three decades. **Ardern-Jones** focuses on skin and drug allergy.

In *critical care* **Grocott** leads a major programme in perioperative care with Jack and Levett (Cat C) including the major WesFIT phase III pragmatic trial assessing efficacy of a prehabilitation programme in patients undergoing cancer surgery.

The group plays a major role in the BRC (Respiratory theme lead **Djukanovic**) and has significant national (e.g. Respiratory TRP) and international (e.g.EU IMI UBIOPRED program) partnerships.

Musculoskeletal: Our musculoskeletal research includes world-leading epidemiology (**C Cooper, Harvey, Dennison, Walker-Bone, K Ward**) led by the MRC LEU (**§1.2.5**), augmented by translational research in inflammatory arthritis (**Edwards**, **C Cooper**, European League Against Rheumatism Centre of Excellence in Rheumatology Research), elderly care (**H**

Roberts) and a vibrant interdisciplinary programme in biomedical engineering (**Oreffo, Dawson, Evans, Tare**) focusing on strategies to regenerate bone and cartilage using stem cell technology (**§1.2.4**). Interdisciplinary research in musculoskeletal ageing includes collaboration with the School of Health Sciences in a Versus Arthritis-MRC Centre of Excellence in Sport and Osteoarthritis (Stokes, Adams (UoA3), **C Cooper**), and with Engineering addressing high-resolution imaging and skeletal strength (Schneider (UoA12), **K Ward, Harvey**). The MRC LEU also hosts the Centre of Excellence for Musculoskeletal Health and Work (**Walker-Bone**, **C Cooper**).

Nutrition, Endocrinology and Metabolism: This group conducts internationally-recognised interdisciplinary research which incorporates the metabolism and functionality of fatty acids and nutritional immunology (**Burdge, Calder**, **Childs**, **Miles**); metabolic conditions including obesity, diabetes, fatty liver disease and cardiovascular disease (**Byrne**, **Englyst**, **Holt**, **Sethi**); early life nutrition (**Godfrey**); diagnosing and meeting nutritional challenges in older people (**Ibrahim**, **H Roberts**); metabolomics and the microbiome (**Swann**); and nutritional determinants of resilience and response to therapy in chronic disease (**Wootton**). The research programme is translational, linking pre-clinical science discoveries to public health and clinical applications and has a life-course perspective with strong links to the MRC LEU and to Global Health (**§1.2.5**). The group has substantial involvement in the BRC (Lifecourse Nutrition theme lead **Godfrey**). There is also a strong research programme in interventional cardiology (**Curzen**, **Mahmoudi**).

Clinical Neuroscience and vision science: focuses on clinical and environmental factors that impair brain development and impact on long-term neurological and neurodevelopmental function. This includes neuroinflammation and neuropathology (**Carare, Boche, Galea, Newman, Nicoll**) and neuronal stem cells (**Willame-Morawek**) (**§1.2.4**). Interdisciplinary research is facilitated by the cross-university Southampton Neuroscience Group (SoNG) and the Interdisciplinary Dementia and Ageing Centre (iDeAC; **§1.6**). *Vision science* includes genetic, cell biology and clinical studies of paediatric and adult eye disease with a major focus on retinal diseases (ICS01-09) including new therapeutic approaches such as gene therapy, pluripotent stem cells and retinal cell transplantation with interdisciplinary work in the application of AI to disease stratification (**Lotery, Self, H Lee, Lakowski, Ratnayaka**).

Immunity & Inflammation: the immunity and inflammation group includes **Polak**, (Wellcome Henry Dale Fellow in systems immunology), **Mansour (**MRC NIRG, γδ-T cells in infection and cancer)**,** and the hepatitis group which studies clinical and basic aspects of hepatitis C and B, with national and international partnerships, pioneering the understanding of natural killer cells and innate immunity in hepatitis C (**Khakoo, Blunt**).

1.2.3 Infection and Microbial Science

This theme encompasses public health, primary care, experimental medicine and basic scientific investigation of pathogenesis, prevention and diagnosis of infectious diseases covering virology, bacterial pathogenesis, molecular epidemiology, diagnostics, global health, experimental human challenge, and early and late phase clinical trials. Significant supporting infrastructure is provided by the BRC, the BBSRC National Biofilms Innovations Centre (NBIC) and an EPSRC-funded Network for Antimicrobial Resistance and Infection Prevention (NAMRIP).

Virology research focuses on RNA viruses including rhinovirus, norovirus and coronaviruses as well as chronic infections e.g., Hepatitis C virus and HIV (**I Clarke, Khakoo, McCormick**).

Bacterial research is centred on pathogenesis, pre-clinical development of vaccines and developing new treatment strategies for biofilm infections and the major causative organisms

of bacterial meningitis and sepsis (**Read**, **Christodoulides**), and tuberculosis (**Elkington**). In Chlamydia, **I Clarke** has established the world's largest reference strain Biobank and leads the development of plasmid-based chlamydial genetics to understand virulence.

There are strong multi-disciplinary links with the Population Health and Healthy Ageing and Multi-Morbidity themes, e.g., investigation of molecular epidemiology of *Streptococcus pneumoniae* and other vaccine-preventable bacterial infections, particularly in relation to polysaccharide conjugate vaccines (**S Clarke**) and in the social and genetic epidemiology of Hepatitis C (**Buchanan**, **Khakoo**). In respiratory medicine, primary human cell models are utilised to investigate the pathogenesis of bacterial (NTHi) and viral infectious exacerbations in COPD (**Staples, Wilkinson)**, asthma (**D Davies, Djukanovic, Swindle**) and PCD (**Lucas**) as well as SARS-CoV-2 infection (**Wilkinson, McCormick**).

There are strong interdisciplinary interactions with engineering to develop novel in vitro primary cell culture systems (**Elkington**, X Zhang (UoA12)) and novel diagnostic technologies for rapid point-of-care diagnostics (**Read**, Wilkinson, Morgan (UoA12)). **Clark** leads a programme investigating the operational use of point-of-care tests and interdisciplinary collaborations developing paper-based technologies, flow-based microfluidic and optoelectronic technologies for respiratory (SARS-CoV-2 and Tb), eye, and sexually transmitted infections are being developed (**§3.4.1**). This links to a major research programme in appropriateness of antimicrobial therapy in primary care (Little, Moore (UoA2)).

Southampton is one of few centres in the UK which conducts controlled human infection studies. The world's first controlled infection with *Bordetella pertussis* revealed that colonisation is an immunising event (**Read**) and will enable rapid evaluation of novel vaccines. Controlled human infection with genetically transformed *Neisseria* has been pioneered to enable development of live bacterial agents for expression of immunising antigen within the respiratory tract.

Clinical vaccine trials are focused on the prevention and management of severe bacterial disease and respiratory infection in children and adults including candidate vaccines against meningococcal disease (**Read**), malaria, pandemic influenza, and coronavirus (**Faust**). **C Jones** (Co-director of IMPRINT (IMmunising PRegnant women and INfants neTwork) is evaluating strategies to immunise pregnant women and infants in the UK and globally.

1.2.4. Developmental Sciences and Regenerative Medicine

Southampton has a strong track record in *human genetics and medical genomics* supported by the Wessex Genomic Medicine Centre (Directors **Temple, A Williams)** and the Wessex Regional Genetics Laboratory (Director **Cross**). There is a broad research program in genetic medicine from the study of single gene disorders (**Temple**, **A Collins**, **Pengelly**, **Baralle**) through to identification of genetic factors influencing common disease (**Ennis**, **JW Holloway, Eccles, Tapper**), the identification of somatically-acquired mutations in cancer (**Cross**), and the clinical application of genomic technology for molecular diagnosis and treatment support optimisation of cancer treatment (**Strefford**). **Temple** and **D Mackay** have described, developed diagnostic tests, and lead studies of personalised treatment for novel imprinting disorders (ICS01-04). Functional genomics is used to assess variant pathogenicity with **Baralle** (supported by an NIHR Research Professorship award) and **Vorechovsky** focussing on RNA splicing, **Wheway** on ciliopathies, and **Ennis** on machine learning algorithms**. Eccles** leads the Prospective study of Outcomes in Sporadic versus Hereditary breast cancer study and with **Tapper** has provided key insights into the influence of inherited genotype on cancer pathology and prognosis.

The *Maternal Physiology* group (**Green, Cagampang**, **Poore**) undertake mechanistic studies of how developmental environment contributes to risk of chronic disease later in life as part of the Developmental Origins of Health and Disease (DOHaD) Centre (ICS01-03) with the MRC LEU, nutrition, and global health groups (lead **Hanson)**. This is complemented by studies of epigenetic programming in development (**Godfrey**).

Cheong leads interdisciplinary research developing nano-therapeutics and medical biosensors to understand the biology of endometrium and endometrial associated pathology (endometriosis and adhesions). The placental biology (**Lewis** and **Cleal)** group studies nutrient transport mechanisms across the placenta including development of computational models of placental function (with Sengers (UoA12)).

The Centre for Human Development Stem Cells and Regeneration (CHDSR, lead **Oreffo**) undertakes fundamental research into early development and stem cells together with applied translational research. The Centre's interdisciplinary research harnesses the translational strength of the University together with an innovative Stem Cell PhD programme. Research themes include early embryo development **(Eckert**, **Houghton);** tissue stem cells in bone (**Oreffo**, **Tare**), cancer (**Cragg**, **Packham**), eye (**Lakowski**), and brain (**Willaime-Morawek**); mathematical modelling of stem cell fate (**MacArthur**); and bioengineering and tissue regeneration (**Oreffo, Tare, Dawson, Evans**).

1.2.5. Population Science

This theme encompasses research groups in public health, lifecourse epidemiology and global health. Additional expertise in statistics is provided by a joint appointment with mathematics, Böhning (UoA10), Director of the Southampton Statistical Sciences Research Institute and the Faculty-hosted Research Design Service South Central, and in health economics by the Southampton Health Technologies Assessment Centre.

***MRC LEU*:** World-leading research in the epidemiology of musculoskeletal and metabolic ageing is housed within the MRC LEU (director **C Cooper**; programme leaders **Harvey, Dennison, K Ward, Inskip, Godfrey, Baird,** Barker (UoA3)**, Osmond, Kumaran, Fall**). The Unit has secured continuous intramural MRC funding since its formation in 1979 and will be continued after its reconfiguration as a directly-funded MRC Centre in the quinquennium 2021-26. Its mission is to provide a centre of excellence using epidemiologic methods to delineate the lifecourse aetiology and prevention of osteoporosis (ICS01-02), osteoarthritis and sarcopenia, as well as obesity, type 2 diabetes mellitus and coronary heart disease. The Unit also serves as a hub for national and international cohort studies (the Hertfordshire Cohort Study; Southampton Women's Survey; Health and Employment after 50 Study) and intervention platforms (MAVIDOS (Maternal Vitamin D supplementation in pregnancy and Osteoporosis in the Offspring); Mumbai Maternal Nutrition Study; EACH-B (addressing adolescent behaviour change); and WRAPPED (addressing effective means of modifying the food environment)). The Unit contributes to major national research consortia, most importantly leading the musculoskeletal component of the UK Biobank intensive phenotyping follow-up. It also serves as the focus for the Centre of Excellence for Musculoskeletal Health and Work (director **Walker-Bone**), continuing a long-established programme in occupational epidemiology.

***Public Health**:* The public health group leads interdisciplinary projects to better understand the patterns and causes of poor health and to develop interventions that enhance the prevention, early detection and management of ill health. This includes work on prison health (**Parkes**, **Kendall**), renal disease (**Roderick, Fraser**), and maternal and child health (**Alwan**). **Parkes** leads the healthy communities' theme of the ARC and **Alwan** contributed to the public health

response to COVID-19 by leading the recognition and the quantification of morbidity from COVID-19, having initiated the call to count 'Long COVID'.

***Global Health**:* Supported by the UoS Global Health Institute (leads **K Ward, Norris**), this group undertakes interdisciplinary research to address current and emerging transnational issues in population health and wellbeing and their determinants in a wider socio-behavioural, spatial, political, cultural, environmental, healthcare and technological context. This includes major programmes in nutrition including the TALENT and HeLTI studies (**Fall**, **Kumaran**), the NIHR Global Health Research Group INPreP study (Improved Nutrition, Preconception, Pregnancy and Post-delivery) (**K Ward**, **Norris**); musculoskeletal epidemiology where **K Ward** leads SAMSON (Sub-Saharan Musculoskeletal Network) and is a lead investigator on an NIHR-Wellcome Trust collaborative project on fracture risk in sub-Saharan Africa. **Norris** is Director of the South African MRC's Developmental Pathways for Health Research Unit at the University of the Witwatersrand in Johannesburg and was recruited in the REF period to strengthen Global Heath research. In infectious disease, **McGrath** (NIHR Global Health Professorship) focuses on HIV transmission dynamics, and the impact of antiretroviral drugs on HIV transmission, pregnancy and infant outcomes, sexual behaviour and partnership, and **Elkington** on Tuberculosis. **Head** leads the RESearch INvestments in Global Health study (RESIN) that maps the global landscape of research funding, comparing levels of investment with burden of disease.

***Clinical Ethics and Law*: Lucassen** leads a research programme in consent and confidentiality in genomics and data science (**§1.2.4**).

1.3 Impact Strategy

In accordance with our University mission to "Change the World for the Better", derivation of research impact is at the heart of our strategy. Central to this objective is a strong, innovative and creative culture combined with the ability to engage and build effective relationships with partners (business, public and third sector); knowledge exchange is embedded seamlessly in all our research and education activities. The University Enterprise & Impact Strategy (**§REF5a 2.3**) provides the framework for governing and championing knowledge exchange activities, putting people at its core, with impact generation and sustainability as vital components. Additional input, provided by the IfLS, supports interdisciplinary innovation to tackle health problems. Our impact case studies attest to close interactions with health policy makers, health care providers, associated stakeholders, industry, patients and the public. Our close relationship with UHS provides insight into clinical need and a unique resource for clinical translation, where innovations can be quickly and easily trialled with patients. We are a founding partner of the Wessex AHSN which supports the journey of innovations into the NHS.

1.3.1 Economic Impact

Our Faculty Enterprise Board, chaired by the Associate Dean (Enterprise) (**Cheong**), reviews all patent applications and plans for commercialisation; further support is provided by Enterprise Fellows (**Roghanian**, **Evans**, **Willaime-Morawek**) whose primary role is to make business aware of research expertise present within the Faculty. This includes: i) technology mapping of research activities; ii) targeted promotion and advertising of research activities to the business community through events; iii) brokering introductions between Faculty staff and industry.

The Faculty is supported by the University's Research and Innovation Services (RIS) (**§REF5a 1.5**) impact support team. Supported by MRC Confidence in Concept awards, and building on the success of previous HEIF funding, skills development training is provided for early career researchers in business collaboration and commercialisation (**§2.1.2**). Supported by an MRC

Proximity to Discovery award we engaged with the University's Future Worlds start-up accelerator that supports academic-industry partnering, student and staff entrepreneurship, and spinout and start-up activity (**§REF5a 2.3**), to recruit mentors, investors and industry partners in the biomedical field; showcase innovations; and deliver seminars to engage staff and students interested in entrepreneurship (**§4.3.3**). UoA1 researchers also benefit from the ICURe programme which provides support for potential university start-ups and spin-outs (**§REF5a 2.3**). To showcase UoA1 research to partners and investors we hold "Pitch for Partnership" events with Pharma e.g. with Pfizer, MedImmune and AstraZeneca focussing on inflammation, and with AstraZeneca focussing on immuno-oncology (ICS01-07).

1.3.2 Impact on Policy

The Faculty encourages researchers to engage with policy makers to derive impact from their research and is supported by the University's Public Policy|Southampton (PP|S) unit (**§REF5a 2.9**). This includes both local with Southampton City Council (**Vogel**), national e.g., Department of Health, Department of Transport (e.g., Holgate; ICS01-06) and international e.g., World Health Organisation (WHO) (**Godfrey**, **Hanson**, **Poore**; ICS01-03). Support for researchers includes training events (how to influence policymakers, how to write a policy brief, data visualisation for policy, be a policymaker for an hour), training for researchers appearing before select committees, and publication of policy briefs.

1.3.3 Impact on Society

The Faculty Head of Engagement (**Green**) chairs the Engaged Medicine steering group, which works closely with the University's Public Engagement with Research unit (PERu) and the Health and Wellbeing Public Engagement Hub, to bring together members of the University and Southampton community at a range of engagement events throughout the year. The Faculty also hosts LifeLab on the UHS campus, a purpose-built educational facility with wet lab and dry classrooms used for hands on learning with school children and professional education for teachers (**§4.3.5,** ICS01-03). LifeLab also provides public engagement training and registration as STEM ambassadors for researchers and co-ordinates outreach and engagement activities. Funding is provided from both PERu and Faculty to support development of public engagement activities and the Faculty supports researchers in public engagement via the Southampton Science and Engineering Festival, partnership with the Winchester Science Centre and with the University outreach teams at events such as festivals (**§4.3.5**).

1.4 Support for Interdisciplinary Research

Aligning with the University's strategy, the Faculty of Medicine has a longstanding commitment to multi- and interdisciplinary research. The major research themes within the Faculty cross School boundaries and there are low barriers between faculties, facilitating research between clinical medicine and disciplines in life, physical and social sciences. To support and facilitate cross-disciplinary working, the Faculty has invested in joint posts with other disciplines e.g., mathematics (**MacArthur**, Böhning (UoA10)), psychology (Garner (UoA4)), engineering (**Evans**) and social sciences (**McGrath**). The Faculty contributes to all the University-wide Interdisciplinary Research Institutes (**§REF5a 2.6**) and is at the heart of the University interdisciplinary strategy for Life Sciences. We lead (**Carare**) the Interdisciplinary Dementia and Ageing Centre (iDeAC), a network of ~90 clinical and academic researchers from UoS and UHS. External to the University, the Faculty benefits from the University's membership in national level interdisciplinary research initiatives, including the Rosalind Franklin and Turing Institutes.

1.5 Commitment to Research Integrity and Open Research

The Faculty supports University policies to ensure it meets the highest standards for the conduct of its research. The Associate Dean (Research) sits on the institutional Research Integrity and Governance Committee and completes the Faculty's Annual Research Integrity Report. The Faculty Ethics Committee reviews all research projects not requiring NRES and includes a lay member. The Faculty Research Integrity Champion (**Blaydes**) oversees training of PGR students and provides advice and support to researchers in relation to research integrity.

Specific actions implemented by the Faculty include

- Joining the AllTrials initiative on clinical trials transparency.
- Compliance checks of reporting mandates for all trials sponsored by UoS or UHS.
- Encouraging use of pre-print repositories, especially of Covid-19 research outputs, followed subsequently by commitment to the Wellcome data sharing statement in relation to Covid-19.
- The Faculty's Wessex Institute publishes the Journals library on behalf of NIHR - publishing comprehensive accounts of its commissioned research within its own publicly and permanently available journals.

In line with the University's Open Access (OA) policy, open access of Faculty research output has risen from 82% in 2016 to >91% in 2020. Our Research Publication Specialist provides support and advice on funder requirements for OA and prepares a regular "Research Publication Matters" newsletter for staff and students highlighting open science issues. The Research Management Committee presentations and Faculty leadership blogs regularly cover research integrity, OA publishing, Plan-S, open data and reproducibility. Faculty researchers have also contributed to University Open Research Symposia.

1.6 Research Objectives in the assessment period

Strategic objectives outlined in REF 2014 included:

- Further alignment of Faculty and UHS research strategies, enlisting more NHS researchers into areas of strength and capitalising on the Trust's strong track record in clinical trials activity.
- Underpinning the UHS/UoS Partnership with mutually enhancing infrastructure and defined research capacity, including a human pathogen challenge unit, and enhanced imaging facilities.
- Establishing a knowledge management system and bioinformatics support for the integration of clinical, biometric, lifestyle and nutritional data.
- Using the molecular sciences hub to support new areas of research between nutrition and immunology (including cancer, cohort vaccine studies, birth cohort longitudinal studies of immune responsiveness across generations); and lung cancer studies.
- Establishing a Translational Vaccinology Centre.

These have all been achieved. We have strengthened our partnership with UHS with the renewal of the BRC including respiratory and nutrition research themes and cross-cutting themes of data science, microbial science and behaviour change. This has been accompanied by renewal of the CRF with expanded facilities for experimental medicine, development of a QA regulated Wessex Investigational Sciences Hub (WISH) laboratory (incorporating the

ECMC and Wessex GMC), and establishment of the Wessex ARC. A further step change in bioinformatics and clinical data access has been provided by UoS membership of the Turing Institute and development of the CIDHR that is committed to facilitating sharing of health data for research across Wessex (UoS, Wessex AHSN, UHS, Hampshire Hospitals NHS trust, Hampshire and Isle of Wight Strategic Transformation Partnership).

To enhance interdisciplinary research, we stated we would:

- Expedite the translation of devices into clinical trials/diagnostics/biomarker discovery programmes.
- In partnership with IfLS, build our bioinformatics capability with a value chain that links researchers with expertise in quantitative biology to the integration and analysis of complex clinical and biometric datasets.
- Integrate infectious disease research with interdisciplinary biofilm research.
- Build interdisciplinary neuroscience, linking neuroinflammation and behavioural models to pathologic mechanisms of cognitive decline and neurodegeneration in humans.
- Integrate “imaging in the nanodomain” into medicine research and expedite the flow of projects from medicine through the established crystallography “pipeline” to increase yield of structure-function data.

We have significantly expanded our interdisciplinary research partnerships across the University that has led to a step change in the level of activity in incorporating engineering solutions to solve biomedical research problems. In the assessment period a core module in quantitative biology has been developed as part of our MRC DTP, and we have established an MSc Genomic Medicine with modules in bioinformatics. These modules are available to all PGR students in the Faculty and have supported recruitment of academic staff with expertise in bioinformatics (**Pengelley**, **Rose-Zerilli**, **Gibson**, **Polak, Wheway**, **Walters**). The Bi-OMICs network connects researchers across the University, sharing expertise and promoting interdisciplinary ‘omics research, and CIDHR facilitates access to clinical data. In biofilms we were successful in the establishment of the NAMRIP network and involvement (**Read**, **Faust**) in the BBSRC NBIC and the establishment of an Anti-Microbial Resistance (AMR) laboratory at UHS to test engineering solutions. To support interdisciplinary neuroscience and mental health research we have established iDeAC to support interdisciplinary research to address challenges in the fields of dementia and brain ageing. In imaging, the Faculty has recruited **Menella** with expertise in super-resolution microscopy, developed X-ray Micro-Computed Tomography for non-destructive 3D histology in collaboration with Engineering (**§3.4.1**) and Coherent Anti-Stokes Raman scattering and second harmonic generation for label-free, non-destructive, non-invasive imaging for cellular and tissue analysis (**Oreffo** with **Mahajan** (UoA8)). As part of the development of the CCI, we recruited **Ober** (Professor of Imaging and Biomedical Engineering) with expertise in single molecule microscopy approaches including multifocal plane microscopy, to enable the study of fast cellular transport processes in 3D.

Our strategy for External Partnerships stated we would:

- Develop our collaborative research with GSK to extend into other areas of mutual interest including cancer immunotherapy.
- Pursue similar partnerships with at least one other industrial partner.
- Develop further collaborations with PHE and Dstl Porton, through a Translational Vaccinology Centre that brings together strengths in basic research, preclinical models,

production and clinical trials, with particular focus on developing human challenge facilities.

- Build a new Centre for Cancer Immunology (CCI).

We have grown our research partnership with GSK to encompass cancer and molecular immunology with awards to **Cragg** (cancer immunology), **Polak** and **West** (molecular immunology/systems biology), and **Sanchez-Elsner** (IBD). We have also expanded our research partnerships with Pharma (**§4.3.2**) e.g., **Wilkinson** with AstraZeneca and **Djukanovic** with Novartis. We have developed a world-first human challenge model using genetically modified commensals for vaccination (**Read**) and expanded the delivery of trials evaluating the safety and efficacy of candidate vaccines in the MHRA phase 1 accredited CRF (**§1.2.3**). **Wilkinson** with GSK has completed a phase II trial of NTHi protein vaccine in adults with COPD to prevent exacerbations. We have also established the Wessex Vaccines Hub (**Faust**) to deliver phase I/II/II SARS-CoV-2 vaccine trials including ChAdOx1 nCoV-1 (Oxford), LNP-nCoVsaRNA (Imperial), NVX-CoV2373 (Novavax), JNJ-78436725 (Janssen, **Faust** UK CI) and, in 2021, Medicago COVID-19 vaccine (**C Jones** UK CI), COM-COV (NISEC/DHSC), Pfizer/AZ heterologous prime boost and scheduling, **Faust**, **Read** co-investigators), DIOS-CoVax2 (DIOSynVax/Cambridge), MSD COVID-19 vaccine, and AstraZeneca PROVENT and STORMCHASER monoclonal antibody trials. To further strengthen critical mass in vaccine research we recruited **C Jones** to lead a programme in maternal vaccination in pregnancy. We have also delivered the vision of the Southampton CCI (**§1.2.1**).

1.7 Strategic aims for research and impact for the next 5 years

As described in **§1.2** our current research strategy focusses on:

- multidisciplinary and translational research
- development of the next generation of clinical and biomedical researchers
- increasing the range and reach of our research partnerships
- fostering a culture of innovation and enterprise

To achieve this, we will:

1. Increase the proportion of interdisciplinary research through partnership with other Faculties, specifically, to realise the potential of the two nascent interdisciplinary research centres in clinical data sciences (CIDHR) and dementia and ageing (iDeAC).
2. Work with other UoS Faculties (Engineering and Physical Sciences, Social Sciences Environment and Life Sciences) to develop interdisciplinary undergraduate (biomedical engineering) and postgraduate research programmes to train the interdisciplinary biomedical research workforce of the future.
3. Strengthen the relationship with UHS and other Wessex NHS organisations through establishment of an Academic Health Sciences Centre to ensure our research continues to be responsive to local population needs and to capitalise on the resources and expertise in medical research in Wessex.
4. To maintain and grow our relationship with external funders that support our research infrastructure including the MRC (DTP and LEC), CRUK (Southampton Centre, CTU and ECMC), Bloodwise (Lymphoma research centre), Versus Arthritis (Centre of Excellence for Musculoskeletal Health and Work), and NIHR (BRC, CRF, CTU and ARC).

5. Continue to enhance our support for clinical academic career development through the Southampton Clinical Academic Training Scheme (SoCATS) and increase the number of clinical academic research staff at all career stages.
6. Enhance the sustainability of our research through further development of a core-facility model for research instruments and increase support for open science through investment in technical support for data management.
7. To enhance the support for enterprise units within the Faculty by establishing a transparent and consistent financial process for enterprise related activities to enhance their impact in supporting the health and social care research ecosystem.
8. Capitalise on the establishment of the Engaged Medicine steering group and the appointment of a Head of Faculty Engagement to enhance outreach, public engagement with science and PPI in Faculty research projects.

2. People

2.1 Current Staff

Of our 412 academic staff (**§1.1**), 193 (179.97 FTE) were eligible for REF 2021 comprising 39% female and 61% male, of which 20% are international and over 18% BAME.

2.1.1 Staffing and recruitment strategy

As described in **§REF5a 3.1**, the UoS Education Research and Enterprise (ERE) job family has four career pathways: balanced, education-, research- and enterprise-led. Within the Faculty, clear descriptors for promotion, based solely on merit, exist for each pathway and level. Movement between career pathways is encouraged, reflecting individuals' changing interests and institutional requirements. ERE promotions and pathway movements are initially considered within the Faculty, followed by the University-level Academic Promotions Advisory Group. Promotions and in-level transfers at level 6 (Associate Professor) and level 7 (Professor) involve an interview panel chaired by a member of the University Executive Board **(§REF5a 1.3**). Annual appraisals are required for all staff and outcomes are moderated by the next-level manager, with University Executive Board scrutiny to ensure University-wide consistency (**§REF5a 1.3**).

The Faculty is succession planning for staff retirements through recruitment and internal promotion. During the assessment period we have recruited 7 male (2 clinical) and 4 female (1 clinical) professors, and 10 male (7 clinical) and 10 female (7 clinical) associate professors. We have made strategic appointments in core areas of research strength to ensure sustainability in areas where there have been senior retirements e.g., respiratory (**M Jones**, **Staples, Kurukulaaratchy**) and nutrition and metabolism (**Swann**, **Childs**), and to enhance areas of growth e.g. Cancer Immunology (**Ober**, **S Ward**), and genomics (**Pengelley**, **Wheway**, **Walters**), public health (**Alwan, Plugge**) and global health (**K Ward**, **Norris**). All new posts are discussed at the Faculty Operations Board to ensure that new academic posts are only appointed where their expertise will synergise with our strategic research themes.

2.1.2 Support for Career Development

We uphold the Researcher Development Concordat and move ECRs to permanent contracts after working in the University for four years. When a researcher's short-term contract has less than six months left, meetings with their supervisor are held to plan transition to a new contract where possible. We have invested in supporting the career development of external fellowship

holders through transition to permanent contracts (in all cases for 5-year intermediate fellowship holders (**§2.2.1**)).

All new research staff undergo probation, with regular supervision meetings with specific objectives set for the first six months, a written personal development plan, and review at 3- and 6-months. Research training support includes a research skills training programme (research methodology, epidemiology, statistics, communication, presentation skills, etc.), transferable skills programme (scientific writing, work-life balance, grant writing etc.), and professional development workshops (time management, leadership skills, building/managing research teams, public impact, teaching skills). This training programme is available to all staff at all levels. Further support is provided by senior academics (mentoring, reviewing grant/fellowship applications); Research and Innovation Services (grant application support, interactions with industry, collaborations with external institutions, intellectual property); and members of the CRF, BRC, UHS R&D, CTU, RDS etc. in accordance with the trainee's needs/project.

Our Faculty fellowship mentoring process supports individuals to apply for external fellowship awards and is overseen by Fellowship Champions (**Holgate** and **Johnson** (clinical), and **S Ward** (non-clinical)) who hold regular drop-in clinics. Individuals complete an EoI 12-months in advance of application which is reviewed to assess appropriateness of the targeted scheme. Mentors are assigned to prospective applicants to support proposal development. Interview training and mock interviews are provided with support from RIS.

The University is a signatory to the Technician Commitment to ensure visibility, recognition and career development for technicians working in the Faculty. We have expanded eligibility to ECR training programmes and ability to present to PGR/ECR research conferences to technical staff to recognise their contribution to the research environment.

2.1.3 Study leave and flexible working

The faculty follows the University Policy (**§REF5a 3.2**) with respect to sabbaticals/ study/ research leave. Provision is made for clinical staff to flex their University/NHS clinical service balance. Flexible or remote working is routinely enabled where needs are identified. Between 2014 and 2020, 66 members of staff requested and were granted a change to their working pattern. Staff policies apply equally to both full-time and part-time staff, and within the Faculty no distinction is made between full and part-time staff in the allocation of resources.

2.1.4 Faculty Mentoring service

The Faculty provides all staff with access to a mentor, for either long-term or one-stop mentoring, as an independent source of career advice and support. Mentors are listed on a mentoring database which contains >100 academic and non-academic mentors (49% female). Mentees can search for mentors using key words e.g., research field, expertise in fellowship applications, or seniority. Alternatively, the mentoring co-ordinator suggests possible individuals for mentees to select from. The mentoring scheme is promoted within the Faculty, at induction and at appraisal. Speciality mentoring for parental leave (maternity, paternity and adoption) was introduced in 2014. Training is provided for both mentees and mentors in the language of mentoring to ensure relationships are productive, and workshops on life-work balance, appraisal, and career progression are provided.

2.1.5 Enterprise and innovation skills training

The Faculty has a programme of activities designed to build new and sustainable partnerships and create opportunities for engagement with business. This programme fosters engagement with business, increasing the proportion of funding from industry to support new health and

medical research and innovation. This programme is run jointly across the University EPSRC, ESRC & STFC IAAs as well as the MRC CIC to encourage and stimulate interdisciplinary innovations.

Training on business collaboration includes a 2-day residential led by an external consultant, and a networking event with businesses. The business & commercialisation fellowship is a new opportunity for ECRs to join the cohort of similar EPSRC IAA-funded fellows, enabling candidates to immerse themselves in developing an understanding of the essential elements for commercialisation (e.g. contracts, IP, licensing, deal making, negotiating, business planning, investor readiness and market appraisal), shadow and network with practitioners, professional advisers and investors. Innovation and ideation sandpits bring ECRs from all disciplines together, enabling their expertise to create new solutions to health and medical challenges Secondments enable development of sustainable relationships with new businesses.

2.1.6 Contribution, Integration and development of NHS Clinical Researchers

As described in **§1.2,** we have a close partnership with University Hospital Southampton which ensures that the UHS R&D strategy and our strategy are aligned, and that we jointly support research active clinicians within the Faculty and Trust. Clinical academic trainees are overseen by the Southampton Clinical Academic Training Scheme (SOCATS, **§2.2.3**), and the Southampton Academy of Research (SoAR, **§2.4**). All consultant appointment panels have representation from the Faculty to assess research strategic alignment. UHS and UoS collaborate to allow flexibility in career trajectories with individuals able to switch between UHS and UoS appointments to reflect increased research activity. For example, in the REF period **A Davies**, **Iverson, Curzen** and **Rangarajan** have moved from UHS to UoS appointments at Professorial Level. Research active physicians and allied health professionals are offered honorary UoS contracts allowing access to research facilities and facilitate integration into the Faculty. They can apply for Honorary Associate Professor/ Professor titles via the UoS promotion process. Currently in UoA1 we have 42 honorary Clinical Senior Lecturers, 9 honorary Associate Professors and 7 honorary Professors, five of whom were appointed in this period.

2.2 Support for early career researchers (ECRs)

2.2.1. Postdoctoral Researchers

The University's Centre for Higher Education Practice (CHEP) supports ECRs through training and networking events. The Faculty Postdoctoral Association (PDA) aims to enhance the development of ECRs, nurture careers, helping individuals to achieve their research goals. The PDA Steering Committee includes the Chair and Faculty Concordat Champion (**Boche**), Faculty Mentoring Chair (**Englyst**) and at least one ECR and academic member from each School to represent the diversity of ECRs and career pathways. ECRs are automatically members of the association and are welcomed by their representatives and given information on the purpose and support provided by the PDA including:

- Annual Open Forum to highlight information and advice on Faculty services - Library, Human Resources, Concordat, Facilities, Careers and Employability, and RIS.
- A Transferable Skills Programme (**§2.1.2**).
- Mentoring **(§2.1.4**) and peer mentoring groups.
- Annual Research Conference showcasing PGR and ECR research and providing presentation and networking opportunities.

- School Research Clubs providing informal presentation and networking opportunities and allowing discussion of issues of common concern.
- Career Events with speakers holding a PhD but working outside academia to highlight opportunities beyond academia.
- Annual PDA Christmas Lecture delivered by a distinguished speaker on their academic journey, including the ups and downs, to inspire our ECRs.
- Dean's Awards to emphasise that working in academia comprises Citizenship (e.g. delivering seminar programmes, workshops or mentoring/ pastoral support), Education (e.g. contribution to curriculum development), Enterprise (e.g. establishing a successful industry collaboration) and Public Engagement (e.g. organising an effective outreach event).

We have developed an on-line interactive Career Roadmap to assist ECRs in identifying their preferred career path and the necessary next steps for progression including case studies from faculty and former staff/ students.

Via the Committee Chair, the PDA liaises with the University Concordat Working Group, to ensure that the principles of the Concordat are implemented within the Faculty.

The Faculty offers an annual postdoctoral career track fellowship providing 2 years' salary and research costs support to the most promising ECRs together with intensive mentoring to support them in obtaining external fellowship funding. This has been highly successful with award holders in the assessment period winning external fellowships e.g. Wellcome Sir Henry Dale (**Polak**), EPSRC Early Career (**Dawson**), Leukaemia UK John Goodman (**Rose-Zerilli, Blunt**), BBSRC Future Leader (**Loxham**) or significant external research awards e.g. **Vogel** (NIHR Public Health Research Grant). The Faculty commits to creating permanent positions for successful 5-year fellowship holders or MRC New Investigator Research Grant awardees, e.g. **Sean Lim** (CRUK Clinical Scientist), **Dawson**, **Polak**, **Mansour** (MRC NIRG) and **H Lee** (MRC Clinician Scientist) in the current assessment period.

2.2.3 Clinical Academic Trainees

For Early Career Clinical Academics, the Southampton Clinical Academic Training Scheme (SoCATS) with Health Education England-Wessex (HEE-W), focuses on developing outstanding academic clinicians who undertake high-quality research for NHS benefit. SoCATS supports clinical academic trainees at all stages of their career, including Foundation Trainees (FY1 and FY2), Academic Clinical Fellows (ACFs), research training fellowship holders, clinicians undertaking higher research degrees (PhD/DM) and Clinical Lecturers (CLs). There are 36 ACFs and 16 CLs in post in HEE-W/UoS (July 2020). Sixty-one (59%) of the 103 pre-PhD ACFs who completed their ACF post in Southampton by 2020 have undertaken, or are currently undertaking, a higher degree, ensuring progression along the clinical academic training route. Sixteen have gone on to take up CL posts, and 2 are currently Associate Professors at UoS.

Of the 36 CLs (7 female, 29 male) who have completed their CL post since SoCATS' inception in 2006, 86% remain in clinical academia, including:

- 5 Professors (4 male, 1 female)
- 9 Associate Professors (6 male, 3 female)
- 7 honorary Senior Lecturers (6 male, 1 female)

- 10 other research positions (including research-active Consultant roles or holding Senior Fellowships) (all male).

The ACF/CL programme is overseen by an Executive Group, comprising SoCATS Director (**Dennison**), Associate Dean Academic Training HEE-W, SoCATS Manager and clinical leads for academic foundation training (**Cutress**); ACFs (**Copson**) and CLs (**Galea**), and trainee representation. Trainee representatives on SoCATS ensure trainees are kept informed and can feed into/shape training schemes appropriately. Research training is trainee-centred, ensuring ACFs/CLs achieve relevant research competencies and generate high-quality data to compete for fellowships to enable development into international-level senior academics. ACFs/CLs are fully integrated into clinical training, encouraged to attain clinical competencies early, consolidate these throughout specialty training, and achieve excellence in their chosen clinical and academic speciality. An Academic Lead oversees academic training for each specialty. All trainees have an Academic Supervisor who, as part of the trainee's research supervisory team, directs their academic training. Trainees complete an annual personal development plan with their Academic Supervisor. Trainees are actively encouraged to select and meet with a senior clinical academic mentor with mentoring experience (**§2.1.4**). Networking is facilitated through regular symposia and annual Faculty/UoS conference and social events with other trainees and senior academics.

2.3 Postgraduate Research students

In the REF period 427 PhD students (31% international, 57% female) were registered in the Faculty of Medicine, ~98% supervised by UoA1 staff (compared to 129 over 5 years in REF 2014), and 400 PhD and 41 DM students with lead supervisors in UoA1 completed in the REF period. Currently we have 230 doctoral students registered in the Faculty (including 46 with cross-faculty supervision), all jointly supervised by two or more academics. Additionally, we have 61 students jointly supervised but registered with other faculties arising from interdisciplinary research collaborations (mainly Engineering and Physical Sciences, and Environmental and Life Sciences). As well as a 3-year PhD programme, we offer a 4-year Integrated PhD in Biomedical Science with pathways aligned with our major biomedical research strengths: Infection and Immunity, Cell Biology and Immunology of Cancer, and Stem Cells.

Since 2014 we have been awarded two new DTPs: the MRC DTP in Translational Immunology, Inflammation and Cancer (joint with QMUL, lead **J Collins**), and the BBSRC South Coast Biosciences DTP (SoCoBio), partnered with, Kent, Sussex, Portsmouth and NIAB-EMR (Director Terry (UoA5), Faculty lead **Lewis)**. The MRC DTP is designed to address key UK skills shortages in translational medicine, notably in the priority area of 'big data' through provision of specialist training in Mathematical and Quantitative Biology, involving statistical, bioinformatic and computational approaches and incorporating enhanced training in transferable skills. Since 2015-16, 56 students have been registered on the programme including 38 match-funded MRC DTP students, 8 ICASE students and 10 MRC National Productivity Investment Fund students with partial matched-funding from industry, charity and UoS. The new (2019-20) BBSRC SoCoBio DTP offers a broad, 4-year research training programme which provides students with the skills they need to develop into future bioscience leaders in academia or in industry.

Additional studentship support is provided by training awards to the MRC LEU and the Southampton CRUK centre (clinical and non-clinical). PGR studentships (providing stipend, training and research costs) are funded through NIHR, MRC and Wellcome Trust Clinical Training Fellowships, medical research charities, competitive studentships funded by the

Faculty, Institute for Life Science, UoS Presidential Scholarships, Public Health England and industry.

2.3.1 PGR Recruitment

All PGR studentships are advertised nationally and internationally, and applicants are assessed by a minimum of two academics who have received recruitment and selection, unconscious bias, and ED&I training.

2.3.2 Monitoring and support of doctoral students, skills development

Our doctoral students undertake an individualised learning needs analysis within the first month of enrolment and agree tailored training programmes. We hold an annual formal assessment with an adviser from outside the supervisory team. All students receive a Research Training and Support Grant (irrespective of whether the funder provides this) for which they are joint budget holders with the supervisor. All PGRs follow a School induction programme, while a Graduate School Handbook sets out policies, procedures and training requirements.

All PGRs take general skills/research training courses, including those focusing on the development of societal impact and open research. These are all mapped to the Vitae Researcher Development Framework. The University Doctoral College (**§REF5a 3.7**) coordinates generic skills training via an online booking system and runs an annual Festival of Research event, facilitating inter-disciplinary engagement.

Students have access to additional research methods training and pastoral support through the programmes run by the Faculty Graduate School and SoCATS (for clinical PGRs). The taught postgraduate research training programme includes: learning needs analysis, study design, epidemiology, library and critical appraisal skills, statistics, presentations, reference management, E-theses, and ethics and governance. Specific research skills training includes: qualitative data analysis, statistical programming in R, bibliometrics, literature searching, systematic review methodology, research data management, and creating a thesis.

Transferable skills courses are available within the Graduate School include: building relationships, mentoring, effective scientific writing, employment outside academia, abstract writing skills, poster presentations, fellowship applications, interview training, teaching skills, networking skills, oral presentation skills, preparing for your viva, voice skills, and winning CVs and job applications.

There is also the opportunity to attend the annual MRC LEU-University of Cambridge Epidemiology for Clinicians course, and the Introduction to Health Economics course provided by the Southampton Health Technology Assessments Centre (SHTAC).

2.4 Southampton Academy of Research

SoAR was established in 2016 as a centralised pan-professional training hub to support health-related researcher career development across the Southampton partnership between UHS and UoS (Medicine (UoA1, UoA2 and UoA4) and the School of Health Sciences (UoA3)) to nurture ECRs and staff who wish to initiate (or re-establish) a research-related career. It serves to co-ordinate training in clinical and biomedical research across allied health professionals, the SoCATS clinical academic training scheme, faculty graduate schools, UoS staff development, the BRC and UHS R&D. SoAR provides information and advice on research-related careers, training, funding and mentorship for health professionals, research scientists, and clinical research staff. SoAR supports clinical researchers in negotiation with NHS employers/HEE to ensure smooth transitions between employers when starting/finishing research positions.

2.5 Equality, Diversity, and Inclusion (ED&I)

The Faculty's EDI Committee, chaired by the Dean, meets quarterly and receives reports from the EDI Faculty lead (**Carare**) and the Faculty champions for Athena SWAN, Racial Equality, Disability Confident, Technicians Charter and Harassment share best practice and progress reports on Faculty level initiatives. An Athena SWAN Silver award has been held since 2015. The EDI committee receives quarterly data reporting changes in staff characteristics at each level and for appraisal completion rates and all progression, promotion, appointment outcomes allowing dynamic scrutiny of gender/ethnicity split to expose any systematic biases at each stage of these processes. Selection panels are scrutinised by recruiting managers to ensure panels have knowledge and understanding of the University's recruitment policy, and mixed gender and ethnicity wherever possible. The Dean has mandated that chairs of all selection panels must have completed ED&I training; currently 85% completion rate for Faculty staff.

In the REF period, the gender balance of teaching & research and research-only permanent academic posts has stayed constant (55% female 2013-14, 53% 2019-20). However, women accounted for 60% (37/62) of academic promotions in the REF period and the proportion of women at senior levels (Associate Professor/Professor) has increased from 30% to 35% and the proportion of female clinical professors has increased from 14% (7) to 24% (13). Overall, the proportion of staff with a recorded BAME background has increased from 14% in 2013/14 to 18% in 2019/20.

The Faculty has increased its PGR applications from women and there are no significant differences between offer and acceptance rates between men and women. The proportion of women currently enrolled on our PGR programmes is 57% with no difference in graduation rates between genders with 85% of students achieving a Masters or Doctorate compared with an average of 75% nationally.

Some of our unique contributions that set good practice locally and nationally are:

1. Mentoring, probation, appraisal and training: In addition to probation for new staff, annual appraisal, and the Faculty mentoring scheme (**§2.1.2**, **§2.1.4**). ECRs and senior researchers are encouraged to seek discipline-specific mentoring outside the University where appropriate through the Academy of Medical Sciences, NIHR, or other networks. To increase awareness of the importance of ED&I in 2020 the Faculty leadership team were assigned widening participation medical student mentors in a ground-breaking reverse-mentoring scheme.
2. Parental leave: ECRs on fixed term contracts that have insufficient time remaining to be eligible to take paid maternity leave can apply to the Faculty maternity fund to extend their contract to ensure they can take paid maternity leave. The Faculty have worked with UHS to ensure we honour continuity of service between organisations e.g., for eligibility for parental leave for researchers whose employment moves between the employers, especially clinical training fellows (who often move between Trust and University), and researchers employed by NIHR infrastructure hosted by the Trust.
3. Public Engagement: We have appointed a Head of Engagement (**Green**) responsible for ensuring gender balance and encouraging female pupils in science by using activities such as LifeLab and ensuring that outreach and engagement activity is recognised by the University in promotion.
4. Intersectionality: our intersectionality mentor (**Alwan**) has received support from the Medical Schools Athena SWAN Network and the Academy of Medical Sciences to create a national network of intersectionality mentors that benefits all medical schools.

5. Staff recognition and rewards: Staff are eligible for Faculty "Shine a Light" Awards made every quarter for Quality, Creativity, Collegiality and Efficiency. The Vice-Chancellor awards annual prizes for Administrative and Operational Efficiency, Career Achievement, Collegiality, Early Career, EDI, International Engagement, Mentoring, Public Engagement and Outreach, Research Impact, Student Experience, Support and Service to the University, and Teaching. An "Most supportive PI" award is made annually to highlight excellence in research mentorship.
6. Supporting wellbeing, support on return from sick leave: All staff and students meet with their supervisors after sick leave to ensure they are well enough to be back working, and that any adjustments are made to their working environment to accommodate their circumstances, with referral to Occupational Health for support where necessary. The University Enabling Services run PGR Conversation Groups for students who would like the opportunity to talk with peers in a supportive and neutral space about issues which concern them. The Faculty runs popular staff wellbeing sessions led by a counsellor.
7. Complementing the PDA for ECRs, we have set up a Faculty network for clinical academics and a BAME females staff support group.

3. Income, infrastructure and facilities

3.1 Income

The annual research income for UoA1 has continued the pattern of increase seen in the previous REF period from £25.4M in 2013-14 to £30.1M in 2019-20. Total income over the seven years was £190.2M (annual average of £27.2M compared to £20.8M for REF 2014) (**Figure 5**).

Figure 5: The annual UoA1 research income has steadily risen throughout the current and previous REF periods 2008/09-2019/20 (change in accounting standard in 2015-16)

Of 2020 grant applications in the REF period, 803 (32.9%) were successful. In addition, the UoA1 benefited from £36.4M income-in kind (£0.2M UKRI, £36.2M NIHR) representing the benefit of the NIHR BRU/BRC, the NIHR CRF and NIHR/CRUK ECMC over the period. In addition, the Faculty invested £25.8M to build the Southampton CCI funded through philanthropic donations and £4.5M from the Solent Local Economic Partnership and raised additional funds (£1.6M) to support equipment, PhD studentships, recruitment of international research staff (**Ober**, **S Ward**), and hosting interdisciplinary research sabbaticals.

During the assessment period UoA1 researchers in the Faculty were awarded 803 grants worth £159.2M with a research income (i.e., research spend) of £190.2M (£151K/FTE/year).

As shown in **Figure 6**, UKRI income (£43.9M) comprises 23% of our portfolio, with awards from MRC, BBSRC, EPSRC, ESRC and NERC reflecting our prioritisation and support for interdisciplinary research (**§3.4.1**).

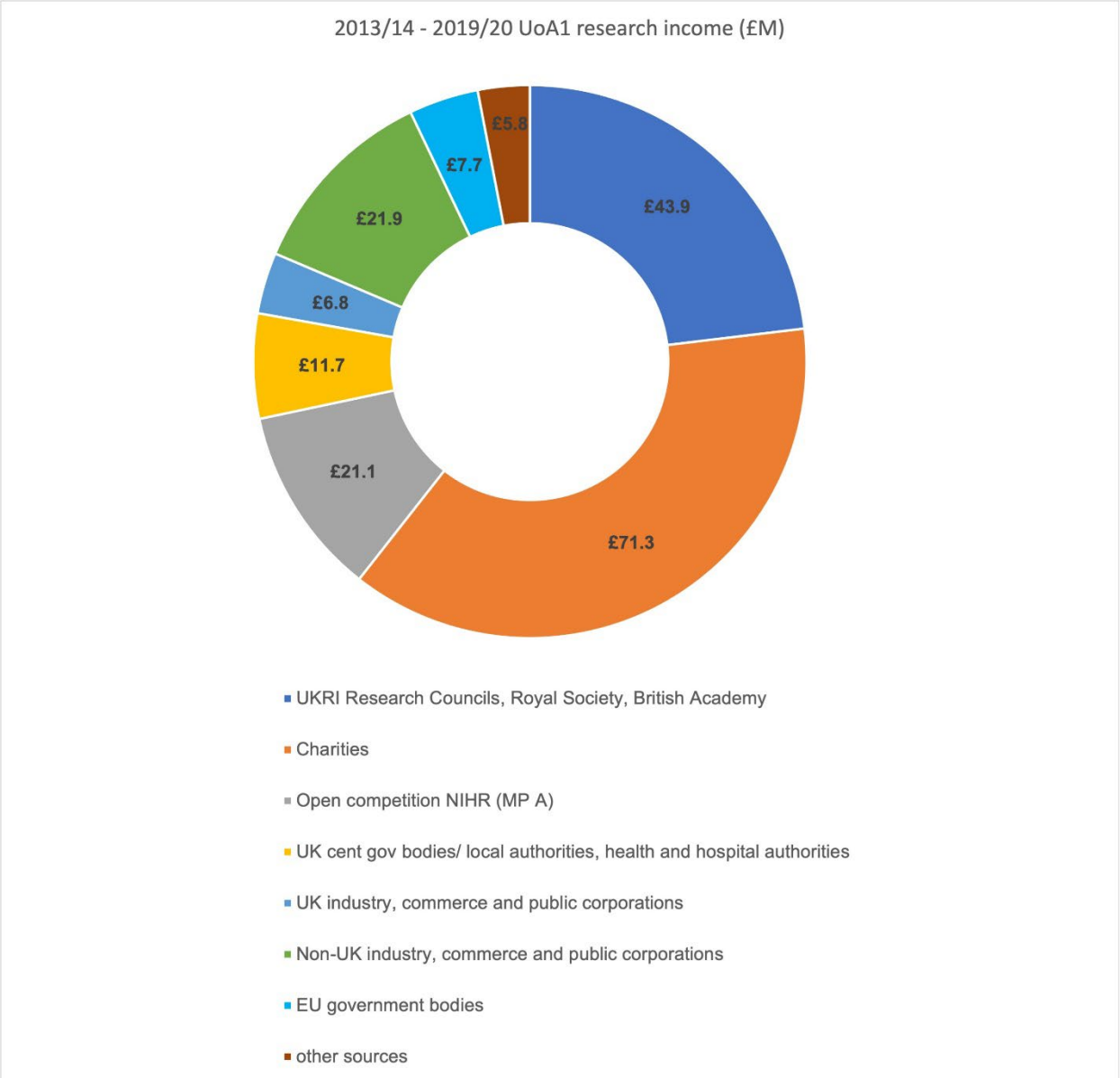

Figure 6 Sources of research income

For example, UoA1 researchers contributed to the successful award to UoS of the £4.1M BBSRC NBIC (**Faust**), the £7.3M EPSRC Trusted Autonomous Systems Hub (**Eccles**) and an EPSRC Transformative Healthcare 2050 award (**Oreffo**, £1.9M) developing novel imaging methods. **Dawson** was awarded an EPSRC fellowship in biomedical engineering (£1.0M) and

Read contributed to a £1.0M EPSRC award developing Raman spectroscopy for diagnosis of infectious disease. The majority of UKRI awards came from the MRC (59%). In 2020, the MRC LEU was renewed for its next quinquennium as the MRC Life Course Epidemiology Centre (Director **C Cooper;** £8.5M) building on four decades of MRC intramural funding. Other MRC awards included a Clinician Scientist award (£1.0M) to **H Lee** in vision science; a NIRG (£0.8M) to **Mansour** in infectious disease immunology; **Read**, **I Clarke**, **Faust** (£1.5M) for experimental human challenge; and **Oreffo**, **Evans** £0.7M from the UK Regenerative Medicine Platform.

We have been particularly successful in winning UK Charity income (£67.5M, 35%). The CRUK Centre was successfully renewed (Director **Johnson,** 2017-2022 £3.9M) together with a non-clinical training award (£2.1M). Other significant awards from CRUK include £3.5M for the CRUK Clinical Trials Centre (**Griffiths**); Programme grants to **Cragg** (£2.2M), **S Ward** (£2.1M and £3.2M from Wellcome Trust); **Elliot** (£1.8M); **Packham** £1.5M; and **Glennie** £0.7M; Clinician Scientist Awards to **Lim** (£1.6M) and **Underwood** (£1.4M), and Accelerator Awards to **Johnson** (£2.1M) and **Forconi** (£1.8M).

Complementing the renewed focus of the MRC LEU on musculoskeletal disease, since 2014 the LEU has hosted the Versus Arthritis MRC National Centre of Excellence for Musculoskeletal Health and Work**,** renewed in 2019 for another quinquennium (£1.1M).

Other major charity funders include the Wellcome Trust with a collaborative award to **Lotery** (£1.4M) in vision science, Schnieder (UoA12) with **Thomas** and **Lackie** (£1.1M) on microCT for histology and a Sir Henry Dale Fellowship to **Polak** (£0.8M), and the BHF with **Hanson** (£1.1M) in developmental epigenetics.

NIHR open competition (£21.1M) represents 11% of research income, demonstrating the strength of the Faculty in translational research. Over the REF period UoA1 staff contributed to the award of the NIHR ARC Wessex (£6.0M, **Parkes**, **H Roberts**, **Wilkinson**), the NIHR Southampton BRC (**Read**, **Godfrey**, **Djukanovic**, **Temple,** Yardley (UoA4)) (£21.8M NIHR income in-kind for Respiratory BRU, Nutrition BRC and renewed BRC over the REF period) and the NIHR Southampton CRF (**Faust**, **Edwards**) (£15.2M NIHR income in-kind). Further support for translational medicine was provided by the renewal (2017-2022) of the NIHR CRUK Experimental Cancer Medicine Centre (**Williams**, **A Davies**, £1.1M over the REF period). In the REF period we were awarded two NIHR Professorships with **Baralle** in genomic medicine (£1.9M) and **McGrath** in global health (£2.0M).

In addition, the Faculty received £21.9M (11.5%) of its research income in partnership with industry (**§4.3.2**).

With respect to ED&I, Faculty research income by head count was 3.6x greater for men than women in 2013-14, reducing to 2.5x in 2019-20. Actions to address the gender gap have included better attribution of Co-I contributions and targeted mentoring of female academic staff.

3.2 Research Support

The Faculty research support team comprises a senior manager, two support officers and a publications specialist, working daily with the Associate Deans Research and Enterprise and RIS (**§REF5a 1.5**). All stages of the research project lifecycle are supported including horizon scanning and influencing calls; targeting calls to key investigators; providing bid support (assessing eligibility, generic statements, impact statements, engaging with University and NHS ethics); internal peer review, mock interviews for fellowships; and project-managing multi-Faculty bids. Research management tools allow monitoring of applications and success rates

for individual investigators allowing better response to needs e.g., providing externally run grant-writing workshops targeted to first time applicants, or those with lower-than-expected success rates.

The Faculty Research Management Committee allocates awards of up to £15k to pump-prime ECRs and inter-Faculty collaborations, or as contributions to multi-user equipment bids. Since 2014 we have made 77 awards, totalling £488k. This has yielded preliminary data supporting new applications to external funders, and initiated collaborations, mostly across Faculties. A second scheme, launched in 2010, provided research expenses for Academic Clinical Fellows and made 14 awards totalling £125k pump-priming development of Clinical Research Training Fellowship applications.

3.2.1 Internal and Cross-Institutional dissemination of Research

Weekly seminars in the Schools, the MRC LEU and the BRC, of internal and external speakers, timetabled not to clash, are well attended thanks to strong cross cutting themes. These are reinforced with specific events such as the annual conferences of the Wessex Immunology Group; the cross institutional bioinformatics and next generation sequencing group (BiOMICS) bi-monthly meetings and annual conference; the cross-institutional Southampton Neuroscience Group seminars and annual meeting; and global and themed interdisciplinary networking events led by the IfLS. The Faculty annual research conference offers PGRs, academic clinical fellows, ECRs and their interdisciplinary collaborators in other Faculties opportunities to present their work. The Doctoral College also runs an annual research showcase providing opportunities for PGRs to present their research to the whole University community.

3.3 Facilities

3.3.1 Translational Medicine Facilities

Southampton Centre for Biomedical Research: the SCBR supports experimental medicine, clinical research and trials. Centred around a five-storey complex of clinical and laboratory space for translational research, it includes the CRF, BRC and WISH laboratory and also hosts UHS R&D.

The NIHR Southampton Biomedical Research Centre is a 5 year (2017-2022) £14.5M NIHR investment in experimental medicine infrastructure. The annualised funding consistently gears a 9-fold capture of external research funding. The CRF (**Faust**, **Edwards**) delivers over 250 phase I and II and complex phase III trials and has MHRA phase I accreditation. The facility fully integrates 2000m^2 of trial infrastructure into UHS, offering early phase facilities and first-in-man expertise rapid feasibility and start-up, with in-house trial support, full integration into the hospital high dependency ward and overnight-stay capable adult and dedicated paediatric wards. Facilities include bronchoscopy, endoscopy and metabolic study suites, and quality assured processing and analytical laboratories for accurate phenotyping of complex patient groups. The CRF also incorporates a treatment room with clean-room ventilation (e.g. for intraocular injections/sampling and skin biopsies), an environmental laboratory with CL2 containment hoods for sputum induction or nebulised drugs delivery. To allow phenotypic assessment the CRF incorporates a micro-CT scanner for measurement of bone microarchitecture; body composition equipment (calorimeters, bio-impedance monitoring); cardiopulmonary exercise testing equipment; tissue plethysmography; microcirculatory imaging; high-resolution ultrasound (to allow US-guided synovial biopsy for musculoskeletal studies and disease stratification biopsies in cancer trials); and a dedicated research dual energy X-ray scanning (DXA/DEXA).

Wessex Investigational Sciences Hub (WISH) laboratory: The WISH laboratory was established as part of the SCBR to provide a fully quality-assured laboratory for discovery science/novel assay development within clinical trials in immunology, genomics, microbiology and nutrition. It hosts the ECMC, the Wessex NHS Genomic Medicine Centre and the Faculty genomics core including liquid handling robots, next generation sequencing and laser dissection/single cell sequencing. Immunometric analysis for pharma CTIMP trials is supported by a FACS Canto II and Aria (3L) cell sorter, Luminex multi-plex analyte analysis and ELISA/ELISPOT.

Patient and Public Involvement (PPI): PPI support is available for UoA1 researchers from all stages from inception to publication, including developing new research questions, improving study processes and materials, interpreting findings, and shaping final reports and dissemination. Comprising nine founding member organisations, the Wessex Public Involvement Network is a regional group of staff and PPI contributors working within NIHR organisations across Wessex including the BRC, CRF and ARC and the RDS. The group aims to establish the area as a beacon of best practice in PPI, impacting positively on the reach, relevance, and refinement of applied health research. Additional support for PPI activities and for achieving impact through public engagement (e.g., ICS01-03) is provided by LifeLab.

Southampton Clinical Trials Unit (SCTU): the SCTU is UKCRC registered with expertise in the design, conduct and analysis of multicentre clinical trials and other well-designed studies. Supported by core awards from both NIHR and CRUK, since August 2013 the SCTU received more than £17M in clinical trial research grants, has recruited over 10,000 patients into its UK and international clinical trials, coordinated over 80 studies, and has driven major advances in a number of disease areas including urology, breast, and gastro-intestinal cancer, and lymphoma (ICS01-08 and ICS01-10).

Research Design Service (RDS): The Faculty hosts the NIHR RDS South Central (Director Reading) providing research design and methodological support to health and social care researchers. RDS staff contribute to research training for UoA1 staff and provide annual NIHR focussed grant application workshops.

Health Economics: The Faculty hosts the Southampton Health Technology Assessment Centre within the Wessex Institute. SHTAC has extensive expertise in evidence synthesis and meta-analysis and health economic analysis and is available to support UoA1 researchers.

Research Imaging: A joint UoS-UHS Research Imaging Management Group supports clinical imaging for research (chair **Galea**). Facilities include 4 high-resolution multi-detector Computed Tomography scanners and 6 Magnetic Resonance Imaging (MRI) scanners. UoS forward pays for 25% of imaging time on the most advanced MRI scanner (Skyra 3 Tesla, Siemens) to ring-fence research time, guaranteeing that MR scanning availability is always immediately available, especially for research studies recruiting acute patients. Additional imaging modalities available for research include:

- Two SPECT-CT systems, capable of both diagnostic and molecular radiotherapy work.
- Ultrasound - with ultra-high resolution high frequency, compound imaging capability, Doppler enabled scanners with a full array of transducers.

Imaging researchers can have their MR images pushed from the scanner to a server (and a mirror site) hosting XNAT (Extensible Neuroimaging Archive Toolkit), an imaging informatics platform, providing local archiving and the means to share anonymised imaging data. A MR imaging pump-priming research project scheme is run by the Research Management Committee.

3.3.2 Biomedical Facilities

The UoS/UHS partnership benefits from its shared facilities on a single site. The SCBR, CTU, Sir Henry Wellcome Laboratories, Cancer Sciences Building, Institute of Developmental Sciences, MRC LEU and Biomedical Research Facility are all located on the University Hospital campus. In the REF period, the Faculty opened the Southampton CCI (**§1.2.1**), investing £25.4M in providing 4190m^2 of state-of-the-art laboratory space including space to host researchers from other disciplines as part of its interdisciplinary residency programme. The Faculty hosts a number of core facilities open to Faculty, wider UoS and external customers to ensure sustainability and generation of impact:

Biomedical Research Facility (BRF): The BRF supports a range of activities including quarantine/re-derivation via embryo transfer for small animals, breeding for small animals and dedicated large and small animal surgical suites complete with pre- and post-operative area, in vivo imaging (fluorescence and micro-CT), vision-science laboratory, behavioural labs and containment Level 2 suites. The BRF has been enhanced in the REF period with the construction of a new pre-clinical unit as part of the CCI development.

Biomedical Imaging: The Biomedical Imaging Unit (BIU) is a joint UoS-UHS facility for research and diagnostic microscopy. BIU staff provide a complete supporting workflow for all types of imaging from experimental design, proof of concept tests, user training, sample preparation, imaging, processing and analysis of specimens. The unit houses microscopes capable of 2-, 3- and 4D imaging, from brightfield microscopy through to confocal, light sheet, time-lapse, virtual scanning, micro-focused x-ray computed tomography (μCT), scanning electron microscopy (SEM), transmission electron microscopy (including electron tomography & x-ray microanalysis) and serial block face SEM. The BIU also supports the *in vivo* imaging in the BRF. The total capital investment in new and improved imaging modalities in the assessment period has been £2.2M funded from the NHS, Alzheimer's UK, BBSRC and Nikon UK.

Flow Cytometry (FACS) Core Facility: supporting the immunology research platform is a Faculty FACS facility including 18 instruments including dedicated FACS sorting supported by core technical staff.

Histochemistry Research Unit (HRU): The HRU offers a range of histological services to support research in the Faculty, wider UoS and external academic and commercial organisations. The Unit supports processing of cells and tissue samples into a range of mediums including frozen, paraffin and resin for subsequent sectioning and staining by a variety of techniques including tinctorial staining and immunohistochemistry. Also available to users are an Axioskop combined light/fluorescence microscope linked to Zeiss KS400 image analysis software, and a laser microdissection microscope.

Mass Spectrometry and Lipidomics: The BRC Mass Spectrometry (MS) Unit is focused on lipidomic and targeted metabolomic phenotyping for clinical translational studies, including use of stable isotopes to monitor metabolic flux. Techniques available include direct infusion lipidomics by triple quadrupole MS, supercritical fluid UPC2/TQMS for metabolomics, ion mobility quadrupole time of flight MS for detailed structural analysis and high mass accuracy MS for elemental composition. Additional techniques include MALDI and DESI MS imaging, online breath analysis by SIFT MS, analysis of stable isotopes by isotope ratio MS and membrane inlet MS for volatile low mass molecules. UoA1 researchers also benefit from the Centre for Proteomic Research (CPR), housed within a custom-built laboratory located within the Life Sciences Building on the University's Highfield campus, providing proteomic expertise and instrumentation.

Tissue Bank: The Faculty tissue bank is licenced by the Human Tissue Authority and functions as a bridge between UHS and the University supporting 37 research projects, 3 national collections (breast and pancreatic cancers and mesothelioma), an international project which makes derived cell lines globally available, and commercial studies. The bank currently stores approximately 200,000 samples and over the last 10 years released ~35,000 samples to researchers. It is complemented by the NIHR Southampton Research Biorepository in the CRF.

High Performance Computing and Data Science: The Faculty supports data science via the NIHR Southampton BRC data science cross cutting theme, hosted by the Clinical Informatics Research Unit, which provides bio- and clinical-informatic core support to Faculty researchers. This includes:

- Advanced data analysis, data extraction, cleaning, transformation and validation from clinical records.
- Feasibility investigation support (cohort estimation from hospital data and from national HES data, NHS Digital data exploration).
- Genomic data hosting in original file format and processed genomic data hosting (SQL) such as genotype, transcriptomic, metabolomics, proteomics and metagenomic.

The University's high performance fifth generation cluster system, Iridis, one of the largest computational facilities in the UK, is available at no cost to researchers (**§REF5a 4.2**).

To accelerate the impact of digital technologies on public health, clinical diagnostics, self-health management and prevention, researchers in UoA1 (**Lucassen**, **MacArthur**) have been fundamental to the development of a new Coalition for Innovation and Digital Health Research (CIDHR) partnership between UoS, Wessex AHSN, UHS, Hampshire & Isle of Wight STP and Hampshire Hospitals NHS Trust. This capitalises on UoS expertise in computer science, led by the WSI and Southampton IT Innovation Centre (Boniface) and will lead in interdisciplinary digital innovation for the benefit of health care.

Further support for data science is provided via the University's membership of the Turing Institute, giving access to networking opportunities, secondments, internships and project funding. The Faculty has two current Turing fellows including **MacArthur** who is seconded 0.5 FTE to the Turing as Deputy Programme Director for Health and Medical Sciences. The WSI also provides research stimulus funds and access to an EPSRC DTC in Web Science.

3.4 University support for Interdisciplinary Research

UoS has a longstanding commitment to interdisciplinary research, maintaining low barriers between Faculties (**§REF5a 2.6**). To foster new and support existing cross disciplinary research, UoS has four University Strategic Interdisciplinary Research Institutes (USIRIs): Institute for Life Sciences; Southampton Marine and Maritime Institute; Web Science Institute; and Zepler Institute. These provide support for UoA1 researchers to draw upon the wide disciplinary expertise across the University to apply to medical research questions.

3.4.1 Interdisciplinary research in the Life Sciences

As highlighted in **§1.4**, the IfLS (director Smith (UoA5)) facilitates research collaborations between clinical medicine and other disciplines, offering pump-priming awards and PhD studentships for new collaborations that span disciplinary boundaries and a varied programme of conferences, seminars, workshops and poster sessions providing new environments for researchers to explore novel approaches to existing research. Examples of IfLS-initiated interdisciplinary collaborations include in respiratory disease: **D Davies**, **Swindle** and **Blume**

in collaboration with Morgan (UoA12) have developed *Lung on Chip* for predictive models of the airway epithelial barrier (NC3Rs, EPSRC, MRC and GSK). **Djukanovic** and Brodzki (UoA10) led an EPSRC-funded programme to develop topological data analysis for high dimensional imaging) and biological data for stratified medicine in severe asthma and COPD. **Lackie** and **Warner** with Schneider (UoA12) have developed methodologies for routine X-ray μCT for non-destructive 3D histology in partnership with Nikon. In cancer, Faculty researchers benefit from collaborative working with the UK National Crystallography Service in Chemistry (**Cragg**, **Mansour** with Tews (UoA5)). The IfLS facilitated FortisNet collaboration (**Oreffo**, **Harvey**, **C Cooper**, Adams (UoA3)) has brought together one of the largest interdisciplinary groups of clinical, academic and industrial partners nationwide addressing musculoskeletal health from molecule to population.

We have developed strong research programmes in the use of microfluidics for solving research problems e.g. real-time monitoring of bronchial epithelial resistance and engineering multi-layered tissue constructs using acoustic levitation to develop models for respiratory research (**Swindle**, **Blume**, **D Davies** with Morgan, Hill (UoA12)), development of novel microfluidic platforms to enable single cell sequencing (**J West**, **Polak** and **Rose-Zerilli**) and to assess discretely organized neuronal connections (**J West** with Deinhardt (UoA5)). We have also developed a range of collaborations for point-of-care detection of infection including ophthalmic (**Hossain** with Daniels (UoA12)) and respiratory applications (**Clark**, **Elkington**, **McCormick**, **Read,** with Wilkinson and Eason (UoA12)) including LFD viral antigen testing for SARS-CoV-2. Further translation is enabled by the support which the CRF and the CTU provide to engineers for device trials, and an NIHR award to develop an AMR laboratory to trial novel engineering solutions for antimicrobial resistance.

Researchers in UoA1 participate in the University-wide Computational Modelling Group, enabling development of mathematical models of biological process such as antigen prestation (**Elliot** with Dalchau (Microsoft Research)), placental amino acid transport (**Lewis** with Sengers (UoA 12)), and applications of machine learning to estimating gene pathogenicity in Next-Generation Sequencing data and understanding of stem cell pluripotency (**Ennis**, **MacArthur**). In stem cells and regenerative medicine **Oreffo**, **Dawson** and **Evans** have pioneered and patented protected innovative nanoclay and biomaterial strategies to deliver stem cells and growth factors to augment bone formation and wound repair, leading to formation of Renovos Biologics in 2017 (ICS01-01).

In the social sciences, Lucassen contributes to the Centre for Health Ethics and Law at Southampton Law School undertaking research into consent and genetic data (Wellcome Trust, £0.5M), and **McGrath** (joint appointment with Social, Economic and Political Sciences) is developing intervention based on couples counselling for HIV prevention in Sub-Saharan Africa (NIHR Global Health Professorship). **Loxham** (BBSRC Future Leader Fellow in Respiratory Biology and Air Pollution Toxicology; ICS01-06) is developing methods of real-time pollution particulate monitoring in collaboration with the Southampton Marine and Maritime Institute. In Microbial Science there is extensive collaboration with physical scientists (Leighton, Morgan, Eason, Wilkinson, Mahajan, Niu (UoA12)) and basic microbiological scientists (Webb, Keevil (UoA5)) across the University. In recognition of this interdisciplinary research Leighton was elected to Fellowship of the Academy of Medical Sciences. Medicine investigators (**Read**, **Faust**, **Clark**, **Hossain**, **Elkington**) contribute to the National Biofilm Innovation Centre and the Network for Antimicrobial Resistance and Infection Prevention, and with the Zepler Institute for Photonics. UoS spinouts arising from UoA12, Highfield Diagnostics and Sloane Water Technologies, are developing novel sensing devices for point of care

diagnosis and methods for wound cleaning respectively in collaboration with UoA1 researchers.

Further support for interdisciplinary research impact is provided by the Faculty's MRC Confidence in Concept awards that provide support for interdisciplinary projects, prioritising translation of underpinning technologies from the physical sciences, engineering and mathematical sciences into medical and health applications. This award, together with leverage and co-funding from other sources (e.g., EPSRC, ESRC & STFC IAAs and our IfLS Stimulus fund) enables the acceleration of technologies further and faster along the translation pathway. The Faculty together with UHS runs annual "Clinicians Meet Engineers" events, facilitated sessions designed to bring clinicians and engineers together to solve pressing health-related issues.

4. Collaboration and contribution to the research base, economy and society

Research in clinical medicine at the University makes a considerable contribution to the national research base. Not only through our direct research activity but also through significant partnerships with the NHS, local and national government, research funders and industry and internationally through extensive research collaboration.

4.1 Collaboration

The Faculty has extensive collaborations locally, nationally and internationally to support its research. We have strong links across the Wessex region. The Wessex ARC includes partners from 15 commissioning groups, 11 NHS Trusts and 3 other Universities. We are a founding partner of the Wessex AHSN and **Parkes** leads the Wessex School of Public Health working closely with Local Authority public health teams as part of the Wessex Public Health Network - NHS South of England. In 2020 the Faculty engaged with Southampton City Council to deliver a DHSC funded COVID-19 asymptomatic saliva screening programme to frontline council workers and local schools (lead **Godfrey)**.

We collaborate extensively with other institutions. Across the REF period 58% (cf. 55% in 2014) of our publications have co-authors at international institutions and this proportion is rising, reaching 59% in 2020 (Scopus, August 2020). In total our co-authorships are drawn from 5289 institutions including 205 companies and 163 governmental organisations, an indicator of our commitment to co-producing research with end-users. Our co-authors are based at 87 of the top 100 Universities in the 2020 QS World University Rankings, with the 5 highest number of co-authorships with UK institutions at Oxford, UCL, Imperial College, Manchester and Cambridge, and the top five international partners comprising the University of Witwatersrand (South Africa); Yong Loo Lin School of Medicine, Institute for Clinical Sciences and KK Women's and Children's Hospital (Singapore); and Erasmus MC (The Netherlands). As the host institution for the Centre of Excellence for Musculoskeletal Health and Work we partner with Aberdeen, Lancaster, Liverpool, Oxford, Manchester, Salford, Guy's and St Thomas' NHS Foundation Trust and Imperial College, London. The MRC LEU is part of the Cohort and Longitudinal Studies Enhancement Resources (CLOSER) consortium of longitudinal cohort studies. In PGR development Our MRC DTP programme is jointly held with QMUL and with the School of Biological Sciences (UoA5) lead the BBSRC SoCoBio DTP with Kent, Portsmouth, and Sussex.

4.2 Contributions to the research base

4.2.1 Strategic partnerships

The Faculty's major partnership is with UHS. Of the 193 staff returned in UoA1, 72 have joint contracts with UHS and deliver clinical service. As described in Section 3, UHS hosts significant NIHR-funded research infrastructure that is led by UoA1 staff, including the BRC, CRF, and ECMC. In addition, UoA1 staff Peveler (retired) and **Faust** were Clinical Directors of the Wessex CRN in the REF period, and **Faust** served as Associate Medical Director for Research and Development at UHS (now Kipps (Cat C) since 2020). In addition, there are 16 category C staff in UHS with honorary Associate Professor/ Professor titles with significant research collaborations with the Faculty. We also have strategic partnerships with the CRUK, MRC, NIHR and Versus Arthritis via our five hosted research centres (**§1.1**).

4.2.2 Indicators of wider influence, contributions to and recognition by the research base

Research councils: UoA1 members contributed (i.e., advisory roles, panel memberships, etc., not merely reviewing) to the work of research councils, and a wide range of other funding bodies in the UK and overseas:

- BBSRC: Research Committee Members (**Burdge**, **Evans**, **Lewis**, **Sethi**)
- Commonwealth Scholarships Commission: (**McGrath** Commissioner)
- International: World Cancer Research Fund (**Copson**), Qatar National Research Fund (**Burdge**), Invision (**Self**), NIH: NIAID and NHLBI (**Arshad**), French National Research Agency (**Sethi**), Swiss National Science Foundation (**Lucas**), Research Council of Norway (**Beers, Eccles**), US Alzheimer's Association (**Boche**), Health Research Board Ireland (**Byrne**), World Cancer Research Fund (**Copson**), Academy of Finland (**Ennis**), Public Health Foundation of India (**Fall**), EU Horizon 2020 (**Evans**)
- Medical Research Charities: British Heart Foundation (**C Cooper,** Chair Project Grants Committee), Wellcome (**Underwood, Elliot, Packham, Fall**), CRUK (**Al-Shamkhani, A Davies, Crabb, Eccles, Elliot, Lim, Williams**), Versus Arthritis (**Willaime-Morawek**), The Academy of Medical Sciences (**D Davies, Elliot**), Prostate Cancer UK (**Cragg**), Retina UK (**Self**), Asthma UK (**Lucas**), Solving Kids' Cancer (**Gray**), British Skin Foundation (**Polak**) Breast Cancer Now (**Blaydes**), Alzheimer's Research (**Boche**), National Osteoporosis Society (**Dennison**), Crohn's in Childhood Research Association (**Ennis**), SPARKS for Children's Health (**Ennis**), Fight for Sight (**Lotery**).
- MRC: Clinical Training and Career Development Panel (**Khakoo, Primrose**), Non-clinical Training and Career Development Panel (**Newell**), Experimental Medicine Panel (**Wilkinson**), Antimicrobial Resistance Panel (**Read**), Chair, Clinical Academic Research Partnership Panel (**Eccles**), Chair, Nutrition Research Partnership Collaborative Awards Panel, Multimorbidity Panel (**Inskip**), Deputy Chair, Population and Systems Medicine Board (**Inskip**), Chair, Population Health Sciences Research Network and Population Health Science Research Group (**C Cooper**), Infection and Immunity Board (**Sean Lim**).
- NC3Rs: CRACK-it panel (**Thomas**), Scientific Committee, CRACK-it panel (**Ratnayaka**)
- NIHR: Senior Fellowship panel member (**Thomas**), Chair Postdoctoral Fellowships panel (**Read**), RfPB (**Inskip, Arshad, Harvey, H Roberts**), Global Effort on COVID-19 College of Experts (**JW Holloway, Elkington**), Advanced fellowships, Integrated Academic Training (**Baralle**), NIHR Pandemic Influenza Studies (**Clark**).

- NERC: Member of Council, Clean Air Programme Steering Committee (**Holgate**).
- Royal Society: Future Leaders – African Independent Research Fellowships (**McGrath**).
- UKRI: Future Leader Fellowship (**Newell, Primrose, Calder**).
- REF: Members of REF 2021 Main Panel A (**Eccles, C Cooper).**

Journal Editorships: 78 staff sit on editorial boards of at least one indexed journal, including 32 holding a significant editorial roles including Editor in Chief: Exploration of targeted anti-tumour therapy (**Packham**), Clinical and Experimental Allergy (**G Roberts**), Diabetic Medicine (**Holt**), Lipids (**Burdge**), Immunotherapy Advances (**Elliot**), Current Opinion in Infections Diseases and Journal of Infection (**Read**), Perioperative Medicine (**Grocott**), Extreme Physiology and Medicine (**Grocott**), Eye (**Lotery**).

***Learned Societies and Other Professional Organizations*:** Staff of all levels offer disciplinary leadership through contributions to learned societies and major (social) scientific organisations including:

American Society for Bone and Mineral Research Council (**K Ward**)

British Society for Allergy and Clinical Immunology Council (**Arshad,** JA Holloway**)**

Chair of the British Society for Genetic Medicine, Member of the Nuffield Council of Bioethics (**Lucassen**)

Chair, British Society for Investigative Dermatology. President, British Society for Medical Dermatology (**Ardern-Jones**)

Chair, Education, Public Engagement & Policy Committee Physiological Society (**Green**)

Chair, European Respiratory Society Scientific Committee (**Djukanovic**)

Director, InVIVO Planetary Health Society (**JW Holloway**)

Member International Advisory Board, Commonwealth Centre for Digital Health (**Batchelor**)

President-Elect, British Society for Allergy and Clinical Immunology (**G Roberts**)

President, Association of Surgeons of Great Britain and Northern Ireland (**Primrose**)

President, European Society for Chlamydia Research (**I Clarke**)

President, Federation of European Nutrition Societies (**Calder**)

President, International Osteoporosis Foundation (**C Cooper**)

President, Society for Social Medicine and Population Health (**Inskip**)

Royal College of Anaesthetists Council (**Grocott**)

Treasurer, British Society for Investigative Dermatology (**Polak**)

Treasurer, Clinical Genetics Society (**Baralle**)

Treasurer, International Society for Developmental Origins of Health and Disease (**Godfrey**).

4.2.3 Academic Recognition

Major honours bestowed on staff 2014-2020 include**:**

Alwan: MBE for services to Medicine during the COVID-19 response and named on the BBC Top 100 women list 2020 for her advocacy on "long-COVID".

C Cooper: OBE for services to medical research. International Osteoporosis Foundation Pierre Delmas Award and Olof Johnell Medal.

Cross: International Chronic Myeloid Leukemia foundation Rowley Prize (2018)

D Davies, **Elliot**, **Godfrey**, **Johnson**, **Primrose** of Fellowship of the Academy of Medical Sciences (joining **C Cooper, Holgate** and **Stevenson**)

D Davies, **Djukanovic**, **Holgate**, **Wilkinson**: Fellowship of the European Respiratory Society

Elkington: MBE for services to Medicine particularly during COVID-19

Godfrey: MBE for services to Medicine during the COVID-19 response

Holgate: KBE for services to Medical Research, Fellow of the Royal Society of Biology, Presidents Medal for Outstanding Service Royal College of Physicians, World Allergy Organisation Lifetime Achievement Award, RCP Faculty of Public Health Bazalgette Professorship, J. Allyn Taylor International Prize in Medicine

Oreffo: Fellow of the Royal Society of Biology, Fellow of International Orthopaedic Research

Stevenson: Jean Bernard Lifetime Achievement award European Haematology Association, Henry M Stratton medal American Society of Hematology, Lifetime Achievement Award British Society of Haematology, Rai-Binet Medal International Workshop on Chronic Lymphocytic Leukemia

The Faculty has one Emeritus (**C Cooper**) and six current NIHR Senior investigators (**Lotery**, **Primrose**, **Grocott**, **Read**, **Faust**, **Godfrey**) returned in UoA1.

C Cooper and **Calder** were Clarivate Highly Cited Researchers in 2020.

4.3. Broader Contributions to the Economy and Society

In addition to our ICS, substantial economic and societal impact has been derived across a broad base of UoA1 research and enterprise activity.

4.3.1 Enterprise Units supporting the research base

The Faculty hosts two significant Enterprise Units, both of which have considerable impact in the national and international health research landscape. The Wessex Institute exists to make a difference to society through research and the way it is prioritised, funded, managed, disseminated and used. It has built extensive UK health and care research knowledge and know-how in the commissioning and management of research and research infrastructure for the UK government and other clients. The institute's expertise covers:

- engagement of research users and producers;
- public and patient involvement and engagement;
- adding value in research; commissioning and monitoring research;

- communications and dissemination of research findings; and
- measuring and improving research impact.

It hosts internationally recognised centres including NETSCC and SHTAC alongside the Health and Care Research Wales funding schemes and consultancy activity. These generated revenue of £110M in the assessment period. NETSCC is one of the main NIHR coordinating centres with responsibility for managing research funding spend of about £150M annually on behalf of the Department of Health and Social Care.

The Clinical Informatics Research Unit's revenue in the assessment period totalled £9.3M. The Edge Platform supports research governance and clinical monitoring of over 90% of the NHS, managing ~100,000 research projects and over 5.5 million patients. The platform has been adopted internationally, including New Zealand, Canada, Belgium and South Africa. Globally, CIRU is working across South America, Africa and Asia capacity building in digital health strategies as well as implementation research in scaling telemedicine platforms.

4.3.2 Collaborative research with industry

The Faculty has extensive collaborations with industry across all its research themes. This include significant partnerships in respiratory disease and immunology including with Novartis (**Djukanovic**, £2.0M), GSK (**Wilkinson**, £0.9M, **Polak** £0.3M), Unilever (**Ardern-Jones** £0.6M) and AstraZeneca (**Wilkinson**, £1.5M); in infectious disease with Pfizer (**S Clarke** £1.3M); in cancer immunology with GSK (**Cragg** £0.7M), and AstraZeneca (**Crabb** £0.3M) in addition to £5.4m in cancer clinical trial support to the CTU (**Griffiths**); and in population science and nutrition with Nestec (**Godfrey** £4.7M), Benevolent AI (**Godfrey** £1.4M), Pronova BioPharma (**Calder** £0.3M), and Nestle (**Godfrey** £0.5M).

The EpiGen consortium (MRC LEU, Liggins Institute of the University of Auckland, Auckland UniServices Ltd, Singapore Institute of Clinical Sciences, and National University of Singapore) undertakes research to advance understanding of the developmental and environmental processes that influence health through the lifecourse. Partnering with industry, EpiGen has begun to collaborate with skilled computational modellers to apply artificial intelligence approaches to 'big data' and using cohort biopsies as a model system to assess therapeutics. Based on patents filed, the consortium has gained seed-funding through large contracts (>£38M to date) with major industry partners including Nestec, Abbott Nutrition, Danone and BenevolentAI Bio. UoS has made substantial contributions to this collaboration, with its investigators inventors on 4 patent families, including epigenetic prediction of phenotype, predictive use of CpG methylation, and vitamin B6 in maternal administration for the prevention of overweight or obesity in the offspring.

4.3.3 Intellectual property and spinouts

Since 2014, UoS has filed 119 patent applications, where at least one inventor is from the Faculty of Medicine. Currently, there are 83 active cases – either pending applications or granted patents representing 28 unique technologies. Our FWm initiative and the iCURE program (**§1.3.1**) supported UoA1 staff to launch 4 spinouts which have 9 patents filed and have collectively received £10M in investment.

- **Renovos** (co-founders **Oreffo, Dawson**) is an orthopaedic regenerative medicine company, spun out in 2017 developing a series of injectable nanoclay matrices for drug delivery with a range of therapeutic applications. Renovos has raised £840k in equity and grant funding to date including, in Jan 2020, an award of £140k by one of

the very first charity investments in the UK through Orthopaedic Research UK (ICS01-01).

- **Kargenera** (**Khakoo**) is designed to bring a first-in-class therapeutic to target natural killer cells to the clinic. The work is based on investigating how natural killer cells target viral infections and cancer arising from MRC and CRUK awards that has led to design and pre-clinical development of a novel first-in-class NK cell therapeutic with encouraging results in a number of different tumour models. The company is underpinned by three patent applications by UoS.
- **Vivoplex** (**Cheong** and Morgan (UoA12)) is developing an intra-Uterine device that provides real time and accurate intra-uterine monitoring with applications in fertility. Vivoplex raised £3.9M in Clinical Stage funding in 2020.
- **Trimuinicor** (H Clark (leaver)) is focused on finding solutions to combat neonatal chronic lung disease through development of natural anti-inflammatory and anti-microbial protein surfactant, protein D for a broad range of anti-inflammatory lung diseases (MRC DPFS funded clinical trial).
- **Gyroscope** is developing gene therapies for the treatment of eye diseases linked to an unbalanced complement system of which **Lotery** was an academic founder in 2017. In addition to the use of bevacizumab for wet-AMD treatment (ICS01-09), Supported by Gyroscope Therapeutics, **Lotery** identified patients with rare genetic variants causing dry AMD, leading to the first dry AMD patients being treated with gene therapy, that then entered in Phase II trials in 2019.

4.3.4 Contribution to Clinical Guidelines and Public Policy

Faculty staff make major contributions to development of Clinical Guidelines. The Southampton Health Technology Assessment Centre provides evidence reviews to NICE, NIHR and other commissioners. **Shepherd** is Co-chair of InterTASC representing the 9 independent academic research teams who produce health technology assessments on behalf of NIHR and NICE. **Robinson** and **Baird** are expert advisors for the NICE Centre for Guidelines and **Baird** is Vice Chair of Public Health Advisory Committee C.

UoA1 staff contributed to a range of NICE clinical and public health guidelines e.g., respiratory (**Arshad**), dermatology (**Ardern-Jones**, **Healy**), antenatal care (**Alwan**), non-alcoholic fatty liver disease (**Byrne**), Osteoporosis (**C Cooper**), cancer (**Crabb**, **Cutress**, **Gray**, **Primrose**), infection (**Faust**) and kidney disease (**Fraser**). Many members of Cancer Sciences hold leadership positions in the National Cancer Research Institute Research Groups (**Primrose**, **Underwood**, **A Davies**, **Crabb**, **Copson**, **Griffiths**) and the Cellular and Molecular Pathology Initiative (**Thomas**). **Lucassen's** work in consent and confidentiality has had major impact on culture and changes in clinical practice through the Chief Medical Officer's annual report (2017); leading on Genome England's clinical interpretation pathway for ethics and social science and designing UK professional guidance in the field, including GMC guidance.

UoA1 staff serve in a wide range of other positions governmental, professional society and patient group positions. For example, **Read** is member of the UK Joint Committee for Vaccines and Immunisation (JCVI). **Johnson** was CRUK Chief Clinician (2008-2017) and is now National Clinical Director for Cancer at NHS England. **Eccles** is a member of the Royal College of Pathologists, the Royal College of Physicians and the British Society for Genetic Medicine joint committee on medical genomics. **Cheong** is a member of the RCOG scientific advisory committee. **Lotery** is chair of the Royal College of

Ophthalmologists' Hydroxychloroquine Monitoring Guidelines and Genomics committees. **Djukanovic** and **Holgate** contributed to the Asthma UK priority setting exercise in 2019. **Lucassen** served on the Nuffield Council of Bioethics and is a Genomics England Ethics Advisory committee and UK Biobank Board member. **Baralle** leads the Global Patient Registry for the PURA patient foundation, and **Temple** and **D Mackay** are medical advisors to the Child Growth Foundation.

We have made significant contribution to public policy. UoA1 researchers have responded to calls for evidence from Parliament, Government Departments and their Agencies (e.g., 'Chlamydia Screening Programme - Policy Update', for PHE (**I Clarke**), 'Early years healthy development review' for DHSC (**Hanson**, **Godfrey**, **Barker**). We have supported ECRs to participate in internships/exchanges such as UKRI policy internships, Royal Society pairing schemes and Sense about Science's Evidence Week at Parliament (e.g., **Loxham**; ICS01-06), The UoS Policy Fellowship Programme enabled opportunities for decision makers from government and industry to forge useful and lasting connections with researchers including Dr Mark Bale, Health Science and Bioethics, DHSC (visiting Clinical Ethics and Law). UoA1 researchers are also supported to publish policy briefs, accessible summaries of research for policy makers (e.g., "Preconception Health: Challenges and Opportunities" (**Baird**, **Barker**, **Godfrey**)) and our work on DOHaD informs publications such as the WHO Commission on Ending Childhood Obesity report and Public Health England's "Making the Case for Preconception Care" (ICS01-03). Other areas in which we have influenced public policy include outdoor air pollution (ICS01-06) where **Loxham** prepared a report for Transport for London on potential health effects of air pollution on the London Underground and **Arshad**, **JW Holloway** and **Holgate** (chair) contributed to the RCP/RCPCH reports on the long-term effects of outdoor and indoor air pollution that have led to calls for "Ela's law" after the coroner's verdict on role of air pollution in the death of Ella Adoo Kissi-Debrah.

The Faculty also hosts RESIN (RESearch INvestments study) that analyses the UK and global R&D landscape to provide evidence on allocation of research investment resources to support decision-making by research funders, governments, the World Bank, World Health Organisation and the UN. Specific areas of focus include global analysis of infectious diseases funding and funding of Blast Injury research as part of the International Blast Injury Network.

4.3.5 Public engagement with Science

The Faculty makes a strong contribution to both Public Understanding of Science and to Public and Patient Involvement (PPI) in research (**§1.3.3**). The BRC helps co-ordinate the Wessex Public Involvement Network and the Faculty Head of Engagement (**Green**) works closely with the University's Public Engagement with Research unit (PERu) and the Health and Wellbeing Public Engagement Hub to bring together members of the University and Southampton communities at a range of events. Links to the local community are also enhanced by the Faculty's staff volunteering scheme (**Underwood**). The Faculty is represented (**Green**) on the committee for Southampton's bid for City of Culture 2025.

Our staff contribute to ~16 different exhibits (including Alzheimer's, early development, regenerative medicine, nutrition, climate-plants-health, cancer and skin research) at the Southampton Science and Engineering Festival (SOTSEF) which attracts ~8000 public visitors each year. The Faculty has developed a range of public engagement activities in partnership with the Winchester Science Centre such as the highly popular, large 3D

pinball machine called '*The Stem Cell Mountain*', which led to further collaborations with the University and a formal memorandum of understanding. *The Stem Cell Mountain* (and a touring version at UK festivals, open days and science events) has engaged >600,000 people with ideas about how the environment can change what type of cell a stem cell becomes (ICS01-01).

A key element of the Faculty's public engagement is with young people, particularly adolescents, who are drivers for societal change and whose needs and values can shape our health-related science. Our LifeLab facility (**§1.3.3**, ICS01-03) was opened in 2014. Since then, 11,500 school pupils and 334 teachers from 72 schools have experienced specialised teaching sessions. In partnership with UHS and the University's Education School and Mathematics and Science Learning Centre, LifeLab raises teenagers' awareness and interest in the science underpinning health issues and makes positive changes to adolescent health-related attitudes. Over 160 Faculty researchers (including PGRs) have received public engagement training and registration as STEM ambassadors through LifeLab, and 200 have participated in 'meet the scientist' sessions.

Other Faculty activities (**Hanson, Green**) foster engagement with young people and development of 'youth voice' through question time events on big topics like 'Building Superhumans?' (2017), 'Fake Food!' (2018) and 'Toxic!' (2019). Questions come from the public to a high-level expert panel. This is the culmination of a set of activities for Year 12 college students that involve short science talks, hands-on laboratory experience and a scientist-medic mentored session. Faculty researchers also participate in UHS Hospital open days, Pint of Science, and other public events e.g., New Forest Show, Glastonbury Festival, and the Cheltenham Science Festival.

As part of University equality and diversity agendas, the Faculty works closely with University Widening Participation teams to keep Faculty research aligned with societal challenges. Engaging with underserved groups of the public complements the work of the student-run, Widening Access to Medicine Society and a Faculty Easter Residential course which provide information, mentoring and skills-based training to encourage access to the Medical School. Involving our undergraduate medical and postgraduate research students in engagement is key to many of our public engagement activities since they reflect the needs and values of future students and some public may identify better with them as science communicators. Recent developments in Faculty public engagement include using the 'question time method' to gauge young people's opinion (school, college and medical undergraduates) as part of strategic planning for the NIHR.