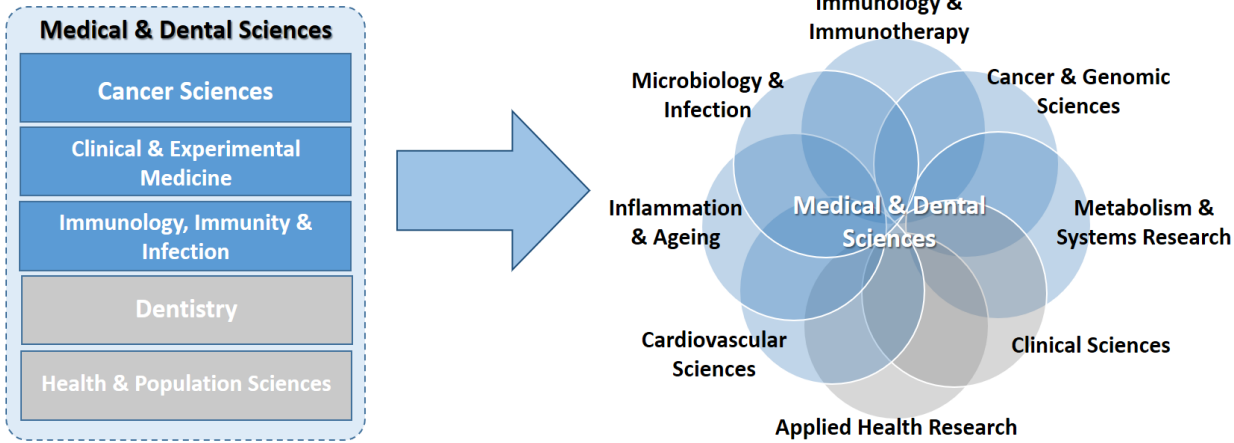


<b>Institution: University of Birmingham</b>
<b>Unit of Assessment: Clinical Medicine UoA1</b>
<p><b>1. Unit context and structure, research and impact strategy</b></p> <p><b>Overview</b></p> <p>An ambitious restructure since REF 2014 of the research environment for Clinical Medicine at Birmingham has achieved transformational change, driven by academic reorganisation and sustained investment in people and infrastructure. An embedded culture of ambition, diversity and interdisciplinarity has greatly enhanced the impact of our work. Within UoA1 this has resulted in a 49% increase in average annual research awards between 2013/16 to 2017/20, from £43M to £64M. Research publications have increased by 37%, from 837 in 2014 to 1,140 in 2020, with 52% of outputs in the top 10% of individual journal citations.</p> <p>This success will now be extended through further investment in discovery, translational and data science, together with innovative approaches to support staff development and extension of international reach.</p> <p><b>1. UoA1 Context and Structure</b></p> <p>UoA1 is based within the College of Medical and Dental Sciences (CMDS), one of five Colleges in the University (See REF5a for context). The College is led by Pro-Vice-Chancellor Professor David Adams, Director of Birmingham Health Partners (BHP) and Lead for the Birmingham NIHR Biomedical Research Centre (BRC). The College management structure is shown in Figure 3.1. 231 staff are submitted in UoA1 and contribute to teaching &gt;5,000 students (4000 UG, 700 PGT and 430 PGR). Researchers in UoA1 work closely with colleagues across the campus, demonstrated by the number and quality of interdisciplinary research outputs (e.g. UoA 2-5, 7-12, 14, 18, 20 and 24).</p> <p><b>1.1 Formation of Research-led Institutes</b></p> <p>The 5 Schools in the College returned in REF2014 were reorganised into eight <i>Institutes</i> following an institutional Life Sciences Review in 2015. Six of the Institutes are within UoA1:</p>  <p><b>Figure 1. Restructure in 2015 of the CMDS from five Schools to eight Institutes (Institutes aligned with UoA2/3 in grey).</b></p>

The Life Sciences Review concluded that biomedical research would benefit from the establishment of Institutes with a clear research focus and embedded research-led education. This structure allows support of nimble academic groups able to respond rapidly and effectively to national and international opportunities and challenges.

Major changes included:

- The School of Immunity & Infection was hampered by size and location across four sites and was restructured into the Institutes of Immunology & Immunotherapy (II&I); Inflammation & Ageing (IIA) and Microbiology & Infection (IMI).
- The School of Cancer Sciences was refocused into the Institute of Cancer & Genomic Sciences (ICGS), integrating research in genomics whilst allowing cancer immunology to move into II&I. Success is visible in the capture of CRUK Centre Status and award of 10 CRUK programme-level awards.
- The School of Clinical & Experimental Medicine (CEM) was too large for effective delivery and was concentrated into an Institute of Metabolism & Systems Research (IMSR) and an Institute of Cardiovascular Sciences (ICVS) with disinvestment in neurophysiology. IMSR maintains outstanding expertise in endocrinology, metabolism and maternal health whilst ICVS develops an increasing profile in cardiovascular disease underpinned by substantial BHF investment.

Institute	Director	Research Themes
<b>Cancer and Genomic Sciences</b>	Pamela Kearns	Genomics & DNA repair Bioinformatics & health data science Clinical Trials & Academic Surgery
<b>Immunology and Immunotherapy</b>	David Wraith	Immune regulation Gut and liver inflammation Cancer immunology and immunotherapy
<b>Inflammation and Ageing</b>	Janet Lord	Ageing & Trauma Musculoskeletal Science & Disease Acute Care Research Neuroscience & Ophthalmology
<b>Cardiovascular Sciences</b>	Roy Bicknell	Platelet Biology & Thrombo-inflammation Leucocyte Trafficking & Vascular Biology Arrhythmias & Heart Failure
<b>Metabolism and System Research</b>	Wiebke Art	Metabolism Endocrinology Maternal & Reproductive Health
<b>Microbiology and Infection</b>	Alan McNally	Antimicrobial Resistance Microbiome Research Host-pathogen interactions

**Table 1. Leadership and Research Themes of Research Institutes in UoA1**

Interdisciplinary research is at the core of UoA1 endeavour and boundaries between institutes are fluid with high volumes of collaborative partnership in line with [the University's Strategic Framework 2015-2020](#) (REF5a 2.1.1). This culture is strengthened through a range of **Research Centres** (see 3.1.1).

Furthermore, all Institutes engage with our NIHR translational research infrastructure. Our £13M **NIHR BRC** focusses on inflammatory disease and incorporates groups from all of our institutes as

well as from University departments outside CMDS. It is closely integrated with our NIHR Clinical Research Facility (CRF), the NIHR Surgical Reconstruction and Microbiology Research Centre (SRMRC) and the West Midlands Applied Research Collaboration (ARC), thus providing a powerful engine to translate our discovery science.

## 1.2. Reflection on REF2014

Priorities defined within the 2014 Environment template are shown below and discussed in relation to subsequent delivery:

- *We would utilise the newly awarded CRUK Cancer Centre to increase reach into 'tumours of unmet need' and innovative approaches to Clinical Trials.*

The CRUK and ECMC Centres supported new developments with the recruitment of Professor of Neurosurgery (**Watts**) to initiate a Glioma programme and new posts in lung, oesophageal and ovarian cancer. A Bladder Cancer Research Centre was established in 2020 with philanthropic funding. The CRUK Clinical Trials Unit (CRCTU) underwent a successful quinquennial review and remains the largest clinical trials grouping in Europe. Innovation in trial design initiated the 'Trials Acceleration Programmes' (TAP) in stem cell transplantation (IMPACT) and delivered the National Lung Matrix trial, one of the largest and most complex stratified cancer trials in the world (*Nature*, 2020) and whose impact extended into non-cancer themes e.g. Arthritis-TAP (A-TAP) and the COVID platform CATALYST.

- *We would create a Centre for Maternal and Child Health*

We secured leadership of the national Tommy's Centre for Miscarriage Research (**Coomarasamy**), recruited a Chair in Maternal and Perinatal Health (**Thangaratinam**), established a WHO Collaborating Centre for Global Women's Health, and secured an \$11M grant from the Bill and Melinda Gates Foundation to tackle post-partum haemorrhage in low-income countries. The Centre has delivered five *NEJM* and five *Lancet* publications in the last five years.

- *We will drive our expertise in membrane receptors to translate fundamental research into translational opportunities in areas such as thrombo-inflammation*

We co-invested £10M with University of Nottingham to develop a Centre of Membrane Proteins and Receptors (COMPARE) as a world-leading centre for the study of G-protein-coupled receptors and tyrosine kinase-linked receptors by advanced microscopy. Several transformational recruitments were made (e.g. **Calebiro, Jones, Hodson, Herten**) and output exemplars include targeting of CLEC14 for cancer angiogenesis, CLEC-2 for deep vein thrombosis and GLP1 receptor in diabetes.

- *We will build on the formation of the NIHR SRMRC, the NIHR Healthcare Technology Co-operative in Trauma Management and the Healing Foundation Centre for Burns Research, all created in 2012.*

**Belli**, Chair of Neurotrauma, was appointed as Director of the NIHR and MoD-funded SRMRC and funding from the Scar Free Foundation established a Centre for Conflict Wound Research (CfCWR). The Centre for Trauma Science Research was established in 2019 to act as a pipeline for experimental medicine and trials activity of SRMRC and CfCWR. The Centres are now providing the infrastructure for ground-breaking and novel studies including the first trial of its kind NIHR-EME RePHILL study, which is investigating the effectiveness of giving patients blood products immediately after a major injury or trauma.

- *We will exploit our £24 million investment in the Institute for Translational Medicine (ITM) as a focus for changing healthcare practice.*

The ITM is firmly established as the central hub for translational healthcare research across BHP (see 3.4.1) and has catalysed success in:

- Health Data Research (HDR), through the award of the HDRUK Midlands Site and two HDR Hubs including PIONEER led by **Sapey**.
- Medical Technologies, through £13M EDRF investment over two major SME-focused programmes (MD-TEC and DEMAND Hub)
- Precision Medicine, through the MRC & Versus Arthritis Stratified Medicine Facility (£7.2M) with additional funding from the Wolfson Foundation (£268K).
- Two specialist early-phase clinical trials innovation teams under the CRCTU umbrella: the Devices, Diagnostics, Drugs and Biomarkers (D3B) team supporting small-scale collaborative industry and surgical specialty trials, plus a team focused on inflammatory diseases and advanced cell therapies. The latter supports the £9M Midlands and Wales Advanced Therapy Treatment Centre (MW-ATTC), the £7M Kennedy Foundation-funded A-TAP and the Birmingham NIHR BRC.

### 1.3. Research Portfolio within UoA1

#### 1.3.1 Institute of Cancer and Genomic Sciences (ICGS)

ICGS hosts the Birmingham CRUK Centre and an NIHR/CRUK Experimental Cancer Medicine Centre as well as the largest academic cancer clinical trials unit in Europe (**CR-CTU, Director: Kearns**). ICGS has 63 Principal Investigators (PIs), six of whom hold CRUK programme grants, and including five Birmingham Fellows (REF5a; 3.4.1).

#### Current and future research objectives, and facilitation of impact

ICGS research strategy is delivered around five pillars:

- **Gene Structure and Function**
- **Molecular Oncology, Pathology and Genetics**
- **Bioinformatics and Health Data Science**
- **Clinical Trials**
- **Academic Surgery**

**Gene Structure and Function:** ICGS has internationally-leading discovery science capability in DNA-repair, epigenetics and molecular oncology, linked within the *Birmingham Centre for Genome Biology* (BCGB). State of the art genomics capability was supported by £7M MRC Clinical Infrastructure, including Illumina, single-cell and nanopore platforms.

**Molecular Oncology, Pathology and Genetics:** Two collaborative initiatives form powerhouses of translational research: the Birmingham Bladder Cancer Research Centre (**Bryan**) (2020), building on £2.2M funding, and the Centre for Rare Diseases (**Barrett**) incorporating the largest adult and paediatric rare disease clinics in the UK, with innovative studies such as an international trial repurposing valproate for Wolfram Syndrome.

**Bioinformatics & Data Science:** The Centre for Computational Biology (**Cazier**) builds on UoB membership of the Alan Turing Institute and was key in award of HDRUK Midlands Site status

(2017). ICGS played a leading national role in delivering the national 100,000 Genomes programme (**Morton**), including recruiting 40% of UK cancer samples.

**Clinical Trials:** The CRCTU incorporates the UK Paediatric Cancer Trials Centre (**Director: Kearns, £10.5M core**) and the UK Therapy Acceleration Programmes in haematology and transplantation (IMPACT) (**Craddock**). CR-CTU staff manage >130 active trials within 20 countries and have established two new trials teams (3.4.1).

**Academic surgery** is world-leading in colorectal (**Morton**), head and neck (**Mehanna**) and gynaecology (**Sundar**). They established the Birmingham Surgical Trials Consortium (BiSTC), a Royal College of Surgeons/CR-UK initiative to promote training and clinical trials in surgical specialties and in 2018 secured a £7M NIHR Global Research Unit in Surgery (**Morton**).

Future ambitions are exemplified by £2M recruitment of **Watts** (Chair of Neurosurgery), catalysing the Tessa Jowell Brain MATRIX Trial. This builds on the pioneering Lung Matrix trial (**Middleton, Billingham**), arguably the most advanced global genetic stratification cancer trial. Bayesian trial design underpins innovation in small patient populations (e.g. childhood, molecularly stratified sub-groups, and rare disease). The NIHR Global Research Unit in Surgery will expand initiatives to reduce morbidity and mortality within lower and middle-income countries.

### 1.3.2 Institute of Inflammation and Ageing (IIA)

IIA research focusses on inflammatory processes in ageing, trauma and chronic disease (**Director: Lord**). The Institute hosts five national Centres of Excellence including trauma research benefiting from co-location with the Royal Centre for Defence Medicine. A unique feature is the Institute's strategic location within the Queen Elizabeth Hospital (QEH). IIA hosts an integrated Inflammation CRF, affiliated to the NIHR/Wellcome Trust CRF (**Director: Buckley**). IIA has 40 PIs including eight early career researchers with personal fellowships.

#### Current and future research objectives, and facilitation of impact

IIA research strategy is delivered around four themes:

- **Ageing and Trauma**
- **Musculoskeletal Science and Disease**
- **Acute Care Research**
- **Neuroscience and Ophthalmology**

**Ageing and Trauma:** IIA hosts the MRC-Versus Arthritis Centre for Musculoskeletal Ageing Research (**Director: Lord**), the NIHR-MoD SRMRC (**Director: Belli**) and CfCWR (**Director: Moiemmen**). Interdisciplinary work includes novel anti-scar wound dressings (**Grover, UoA12**) and nanopore technology for rapid infection diagnosis in military and civilian settings (**Loman, UoA5**).

**Musculoskeletal Science and disease:** IIA hosts two themes in the NIHR BRC (Rheumatoid Arthritis and Sarcopenia) and the Versus Arthritis Centre for Rheumatoid Pathogenesis. **Buckley**, a joint appointment with the Kennedy Institute at Oxford, and **Raza** have established the A-TAP and leads the joint element of the Human Cell Atlas project.

**Acute Care Research:** This area is an exemplar of our agility to respond to challenges. This initiative was launched in 2018 in response to extreme demand for improvements in acute care

and lack of appropriate evidence base (**Lead: Gao-Smith**). This established the first NIHR Academic Clinical Lecturer in Acute Care in the UK, launched a bespoke MSc and won a HDRUK Hub (PIONEER, **lead Sapey**) and COVID-19 informatics platform, DECOVID.

**Neuroscience and Ophthalmology:** Strengths include neurotrauma within SRMRC and data science, including the INSIGHT HDRUK Hub (**Lead: Denniston**) and deployment of artificial intelligence (AI) to develop triaging tools for large scale emergencies (**Lead: Belli**). Translation includes diagnostic tools for concussion and anti-scarring dressings & eye drops (**Hill, Di Pietro, De Cogan**).

IIA impact is broad, exemplified by **Belli's** salivary microRNA test for brain injury after concussion, adopted by international sports groups and supported through a spin-out test with POC test and CE mark. Ambitious plans include utilising A-TAP to improve health in 'long-covid' patients, development of the Innovative Therapeutics for Ageing Consortium (ITAC) (£4.9M from Research England jointly with the University of Oxford) and exploiting the Human Cell Atlas for next generation diagnostics.

### 1.3.3 Institute of Immunology and Immunotherapy (II&I)

II&I integrates fundamental research with clinical programmes in cancer, infection and inflammatory disease of the liver and gut (**Director: Wraith**). Leadership roles are held within the NIHR BRC, CRUK Centre and MRC/BBSRC Bactivac Network. II&I has 44 PIs (18 clinical and 26 non-clinical) and five Birmingham Fellows who have all secured long-term funding from MRC (three MRC-career development awards and a new investigator research grant) and CRUK (career establishment award).

#### Current and future research objectives, and facilitation of impact

II&I research strategy is delivered around three themes:

- **Immune regulation**
- **Gut and liver immunology and inflammation**
- **Cancer immunology and immunotherapy**

**Immune regulation.** Research uses cellular and *in vivo* models supported by advanced technology platforms in COMPARE (single molecule, single cell and whole animal imaging) and the £7.2M MRC/Versus Arthritis West Midlands Stratified Medicine Innovation & Translation Facility (CyTOF and single cell analysis) to understand the molecular and cellular basis of immune regulation. Translation is facilitated by the Institute's Clinical Immunology Service (**Richter**) that processes >50,000 samples annually for the NHS with strong links into the NIHR BRC and the BactiVac Network.

**Centre for liver and gastrointestinal research (CLGR):** Outstanding global profile for liver research continues under **Adams** and **Newsome** who lead the NIHR BRC in Inflammation. Outputs include normothermic machine liver perfusion by **Afford** (ICS; REF21) and the £10M Innovate MW-ATTC (**Lead: Newsome**) including CD34+ cell therapy for cirrhosis and £1.7m Sir Jules Thorn Award for Biomedical Research into immune liver disease (**Oo**).

**Centre for Immunology and Immunotherapy of Cancer (CIIC):** Cancer immunology is a pillar of the £5M CRUK Birmingham Centre, led from II&I by **Willcox & Middleton** and supported by £2M Molecular Histology Facility. The £2.4M NIHR/CRUK ECMC (**Lead: Middleton**) catalyses translation to early phase clinical trials and therapeutic approaches include novel stratified

immunotherapy approaches, industry collaborations and spin-out of Chimeric Therapeutics (**Lee/Bicknell**).

Research impact is strong and includes development of lateral flow assays for serum free light chains and antibiotic prophylaxis in cancer patients (**Drayson**).

Future plans include building on the recruitment of **Owen** to exploit COMPARE for analysis of immune synapses and analysis of phase I trials and CAR-T development based on '4<sup>th</sup> generation' CAR-Ts resistant to nutrient deprivation (**Mussai & De Santo**). A cornerstone is the Birmingham Precision Medicine Centre (BPMC) aligning diagnostics to GCP clinical trials which will form the first phase development on the new £210M Birmingham Health Innovation Campus (3.4.3).

### 1.3.4 Institute of Cardiovascular Sciences (ICVS)

ICVS harbours expertise in platelet biology, vascular biology and atrial fibrillation (**Director: Bicknell**) and outputs have included the establishment of COMPARE (**Watson**), a 5-year BHF Accelerator Award (2019) and leadership for a Wellcome PhD programme in inflammatory disease. Research programmes benefit from state of the art infrastructure including unique advanced intravital microscopy suite, and multiple super-resolution light sheet microscopes. ICVS comprises 26 PIs.

#### Current and future research objectives, and facilitation of impact

ICVS research strategy is delivered around three themes:

- **Platelet Biology & Thrombo-inflammation**
- **Leucocyte Trafficking & Vascular Biology**
- **Arrhythmias & Heart Failure**

**Platelet Biology & Thrombo-inflammation:** ICVS is internationally recognised for platelet biology specialising in discovery of new receptors and ligands, genetics of bleeding disorders and mouse models of thrombo-inflammation (**Watson et al**) with CLEC-2, G6b-B and PEAR1 identified as targets for antiplatelet drugs (**Watson, M Thomas, Morgan, Nicolson**).

**Leucocyte Trafficking & Vascular Biology:** A purpose-built *in vivo* microscopy service exploits expertise in leucocyte recruitment and angiogenesis and has supported discovery of shear-regulated genes (**Bicknell, Hewett, Khalia**), drug discovery and spinout company *Viatem Ltd*.

**Arrhythmias:** Our leading profile, including iPS-derived cardiomyocytes as models for inherited cardiomyopathies and arrhythmia syndromes, has delivered outputs including definition of PITX2-dependent aetiology and integrated care programmes with apps and online tools (**Fabritz**).

Impact is broad and, with >20 patents, **Bicknell** (Chimeric Therapeutics) and **Rainger** (Viatem Ltd) established spinout companies including trial of CAR-modified T cells targeting CLEC14A. Trials include humanised monoclonal antibody and recombinant GPVI in clinical trials for stroke and coronary syndromes (**Thomas, Watson**) whilst **Iqbal** and **Rainger** are developing PEPITEM inhibitors to prevent T cell trafficking into vessels.

Future work will include ageing and stem cell therapy in inflammatory diseases together with genomic stratification in atrial fibrillation therapy.

### 1.3.5 Institute of Metabolism & Systems Research (IMSR)

IMSR has an internationally leading profile in metabolism, maternal health and endocrinology (**Director: Arlt**). It comprises 33 PIs (40% female) with a median age of 38 years, achieved through mentorship of local staff and systematic external recruitment including three Birmingham Fellows.

#### Current and future research objectives and facilitation of impact

IMSR research strategy is delivered around three major health & disease themes:

- **Metabolism**
- **Endocrinology**
- **Maternal and Reproductive Health**

**Metabolism:** Key research programmes include energy metabolism (**Lavery & UoA2**), pancreatic islet cell biology (**Hodson**), metabolic receptor biology (**Calebiro, Hodson**) and cancer immune-metabolism (**Tennant**). These interact with translational programmes on metabolic health in women, focussing on polycystic ovary syndrome (**Arlt**), idiopathic intracranial hypertension (**Sinclair**) and gestational diabetes (**Thangaratinam**). Outstanding technology platforms include Metabolic Tracer Analysis Core and Steroid Metabolome Analysis.

**Endocrinology:** Major strengths are steroid endocrinology (**Arlt, Hewison**) and endocrine tumour research, underpinned by one of the largest and most complex clinical practices in the UK with European Reference Network (ERN) Centre-of-Excellence status for rare endocrine and metabolic disorders. Pituitary (**Karavitaki**), thyroid (**McCabe**) and adrenal tumour research (**Arlt, Ronchi**) exploit links with UoA2 to develop diagnostic tests and prediction tools

**Maternal & Reproductive Health:** World-leading strength in (i) Early Pregnancy & Conception (underpinned by Tommy's National Centre for Miscarriage Research (Lead: **Coomarasamy**) and the HFEA-approved Centre for Reproductive Science, Lead: **Kirkman-Brown**), (ii) Late pregnancy and neonatal health (**Thangaratinam, Kilby**), and (iii) Global Maternal Health, recognised by designation as World Health Organisation (WHO) Collaborating Centre for Global Maternal Health (Joint Leads: **Coomarasamy, Thangaratinam**).

Innovative interdisciplinary systems science is utilised by many PIs and was boosted by £7M investment in an interdisciplinary Centre for Systems Modelling & Quantitative Biomedicine (CSMQB; Terry), integrated with Mathematics and Computer Science (UoA 10 & 11).

An outstanding impact profile is seen in multiple REF2021 impact cases, >20 patent files and two spin-out companies, Invex for idiopathic intracranial hypertension (**Sinclair**) and Neuronostics Ltd. for seizure susceptibility assessment (**Terry, Woldman**).

Future plans include interdisciplinary theme in Women's Metabolic Health and integrating CSMQB with core IMSR themes.

### 1.3.6 Institute of Microbiology and Infection (IMI)

IMI operates at the forefront of prevention and treatment of bacterial infection. As a cross-College collective (UoA1 & UoA5), IMI is one of the largest and most successful communities of academic and clinical microbiologists in the world. Several new investigators have been recruited in recent



years, including **McNally (Director)**, **van Schaik** and **Iqbal**, with strong success in attracting Marie Sklodowska-Curie and Birmingham Fellows. IMI has 12 PIs in UoA1.

### Current and future research objectives and facilitation of impact

IMI research strategy is delivered around three themes:

- **Antimicrobial Resistance**
- **Microbiome Research**
- **Host – pathogen interactions**

**Antimicrobial Resistance (AMR):** Key research programmes focus on the genetic basis of microbial resistance and include international collaborations driven by **McNally** and **van Schaik**, in China, Bangladesh and India. Therapeutic innovations have included **Blair**, **Piddock** and **Buckner** developing novel compounds to reduce antibiotic resistance through the inhibition of efflux and the spread of mobile genetic elements carrying resistance genes.

**Microbiome Research:** IMI hosts the Microbiome Treatment Centre (MTC) which produces the only licensed faecal microbiome transplant (FMT) product in England (ICS; REF21) and has delivered >500 therapies for *C.difficile* with >80% success rate (**Iqbal**). The role of microbiome perturbation in gastrointestinal and respiratory disease is spearheaded by **van Schaik** and **Cox**.

**Host-Pathogen interactions:** IMI is at the forefront of host-pathogen interaction research, focussing on gram positive pathogens such as MRSA (**Geoghegan**) and *Strep pneumonia* (**Mitchell**). Both conduct world leading molecular microbiology, with translational work around pneumococcal vaccine development and novel skin anti-colonisation strategies for MRSA.

Impact includes the MTC and political leadership in AMR (**Piddock**). Future aims include development of 2+ new FMT clinical trials and developing the MTC as a self-sustaining clinical service provider, destined to join the enormously successful MicrobesNG as the second IMI spin out venture. IMI staff made pivotal contributions during the Covid pandemic, including setting up the Milton Keynes Lighthouse and Birmingham Turnkey Pillar 2 testing labs (**McNally**).

#### 1.4 Implementation of Research Strategy within UoA1

UoA1 research acts to improve health outcomes within the UK and beyond by training, retaining and recruiting the best research staff and providing them with an outstanding infrastructure to deliver impactful research. Our **research strategy** focuses on enhancing five key elements: **Culture; Partnerships; People; Infrastructure; and Interdisciplinarity**.

##### 1.4.1 Enhancing the Research Culture

The University's 2026 vision aims to deliver '*Research that Matters*' by creating '*a culture that stimulates, nurtures and engenders drive, confidence and ambition*'. This has been the primary ambition within UoA1 since 2015 with promotion of 'intellectual excitement' alongside the highest values of equality, integrity and openness. Strategic delivery has included empowering academic debate, setting and supporting ambitious personal targets and undergoing regular internal and external assessment. Equality, diversity and inclusion (EDI) principles are embedded in every decision and reflected in our Silver Athena SWAN status (Section 2.6). Regular staff surveys show consistent improvements in staff perception of EDI principles.

### 1.4.2 Building Partnerships for Delivery

The physical environment for UoA1 is amongst the strongest in the UK with the Medical School and University campus adjacent to the QEH (part of University Hospitals Birmingham NHS Trust, the second largest NHS Trust in the UK) and Birmingham Women's Hospital. BHP is the clinical-academic accelerator at the heart of Birmingham's Life Sciences engine, a strategic alliance between UoB and these two major NHS foundation trusts. The formation of BHP has catalysed operational and strategic delivery of several key research and training programmes.

This vibrant and integrated health sciences community forms one of the largest healthcare campuses in the UK and an excellent platform for UoA1 research. The campus was designated a **Life Sciences Opportunity Zone** in 2019. Partnerships are described fully in Section 4.

### 1.4.3 Empowering People

Our strategy for recruiting and supporting staff is described fully in section 2 and focusses on embedding processes that ensure optimal recruitment, support, promotion and development, allowing staff to express their full potential.

### 1.4.4 Investment in key Infrastructure (Section 3)

Since 2014 over £100 million has been invested by UoB and partners in new buildings and infrastructure to facilitate UoA1 research. Whilst these are covered in more detail in Section 3, highlights include:

- £24M to establish the ITM (co-investment with BEIS and NHS partners).
- £12.6M from NIHR to support our NIHR BRC
- £12.8M to support NIHR/Wellcome CRF at QEH and BWCH
- £7.2M MRC/ARUK investment for stratified medicine facility
- £13M co-investment with ERDF and NHS to establish Institute for Healthcare Technologies and two SME support platforms (MD-TEC and DEMAND Hub).
- £5M UoB investment for COMPARE imaging initiative (see 1.2).

### 1.4.5 Growing and facilitating Interdisciplinary research

**Interdisciplinary research** is a major strength of the UoA1 portfolio, facilitated by our campus which co-locates all five colleges, and two NHS trusts on one campus. This engages research across STEM, social sciences and humanities and is enhanced by targeted recruitment of interdisciplinary early career researchers and professorial staff.

**The Institute for Global Innovation** (£5M, REF5a; 2.3.3) is led by **Mehanna** (UoA1), UoB's first Deputy Pro Vice-Chancellor for Interdisciplinarity. It incorporates key UoA1 themes of anti-microbial resistance, surgery, healthy ageing and maternal health.

Specific exemplars of interdisciplinary research collaborations are:

- **Healthcare Technologies** with Engineering, building on £7M investment in new facilities within the ITM, supported by a further £6M ERDF investment in the DEMAND (Data-Enabled Med tech ANd Devices) Hub (**Hill, Naylor**).
- **Drug discovery**, £1.5M University investment to facilitate collaboration between CMDS staff and those in the Schools of Biosciences and Chemistry, underpinned by the recruitment of **Roberts** (ex-AZ; now Apconix) as inaugural Chair of Drug Discovery. This initiative includes curation of unique UoB chemical compounds, high-throughput screening

and Drug Discovery Clubs that attract researchers from across the Campus. The recruitment of **O'Reilly** as Head of Chemistry has initiated collaborations focussing on the use of polymers and nanoparticles in medicine.

- Our outstanding capability in **Data Science** is founded on shared research with partner NHS Trusts, Computer Science and Mathematics and membership of Alan Turing Institute, and hosts an HDRUK Site and two of seven national HDRUK Hubs.
- We have embraced UK investment in Global Challenges Research Funding, winning £15M in support and establishing the NIHR Global Health Research Unit on Global Surgery with six international hubs and a policy initiative co-developed with the London School of Economics.

### 1.5 Impact Strategy – overarching aims and outputs at UoA1/College level

UoA1 research has leveraged substantial health and economic benefits and reflects our embedded culture of research impact. Sections 3 and 4 detail our strategies around infrastructure and collaborations with the outline of actions taken at the College/UoA level including:

- A focus on 'research that matters' and has impact. Academic leads for impact are appointed within each Institute and promote and facilitate impact within their environment and meet and exchange ideas at the College Impact Committee chaired by **Ewer**. This committee reports, through College Board, to the University DPVC for Research Impact, Professor Heather Widdows.
- Embedding innovation and knowledge transfer in the culture of the College by:
  - developing research-led teaching including undergraduate and postgraduate modules on impact and knowledge transfer with an innovative industry-placement programme;
  - appointing academic business leads in each Institute to foster and deliver industry partnerships;
  - investment in posts to support business engagement, IP protection and commercialisation (REF5a 2.4.1).
- Nurturing a vibrant research culture of discovery science, encouraging intellectual ambition and supporting our strong programmes of translational medicine. New links between discovery and translation are promoted by targeted investments such as the Wellcome Translational Partnership Award and MRC Confidence in Concept.
- Incorporation of public and patient engagement and involvement in all that we do including the establishment of a PPIE Team providing operational support within the College. This has underpinned the coordination of a large network of PPE/I groups coordinated through BHP to provide a dynamic patient voice involved in regular outreach and public engagement events.
- A new Centre for Patient Reported Outcome Research has been established across UoA1 and UoA2.
- Investment in a city centre hub (The Exchange; REF5a 4.2.2) for effective engagement with the City of Birmingham and its wider population.

### 1.6 UoA1 future research ambitions

UoA1 is committed to extending the significant momentum that has been achieved since 2015. In order to achieve this we will build on four broad themes (with specific initiatives for each institute highlighted in 1.3):

- **We will focus our investment within areas of outstanding research excellence** - We aim to strengthen our competitive position in areas such as DNA repair, immunology, AMR, maternal health, ageing/multimorbidity, data science and clinical trial design. Whilst developing this approach, we will remain flexible to support new areas of expertise built around young investigators of exceptional talent, for example those recruited through our Birmingham Fellows scheme.
- We remain committed to **increasing the breadth and quality of our interdisciplinary research**, further exploiting the power of our integrated health campus. We have appointed a range of **Interdisciplinary Lecturers and Professors** between UoA1 and other schools including Computer Sciences, Mathematics, Engineering and Social Sciences. We are using student ambassadors and research 'speed-dating' events to drive and sustain relationships underpinned with interdisciplinary PhD studentships such as EPSRC-funded DTP SciPhy4Health. In 2019 we invested £7M to recruit **Terry** to lead the Centre for Systems Modelling & Quantitative Biomedicine (2.4.2), incorporating three Interdisciplinary Chairs.
- **Strong and effective partnerships** - We will develop and strengthen local, national and international partnerships across academia, the NHS and industry. We will use our Wellcome Translational Partnership Award to support 'challenge' meetings between NHS and UoA1 researchers to identify new opportunities, build teams and pump-prime investment, exploiting establishment of **Fox** as 'entrepreneur in residence'. We will use our status as one of the six Life Sciences Opportunity Zones by the Department for Business, Energy and Industrial Strategy to extend links with industry. We will deepen collaborations with other universities including Oxford and Nottingham, which have already delivered in excess of £14M funding. We will utilize our recent formal partnership with the Association of the British Pharmaceutical Industries to tackle key issues such as multimorbidity and regulatory hurdles to drug development. We will leverage opportunities arising from the Institute for Global Innovation (4.2) and our global NIHR Centres.
- We are ambitious that our research leads to **measurable change in clinical practice** and an **increase in commercialisation**. To maximise our interactions with industry we have appointed academic leads for enterprise within each Institute and helped to instil and secure a culture for knowledge exchange. In addition we will exploit £6.8M investment in the BioHub Incubator which offers fully equipped laboratories with regulatory advice, a medical devices testing pathway and a BizzInn business incubator. Moreover, we will complete development of the Birmingham Health Innovation Campus, a 9.9 acre and over £200M joint investment for life sciences enterprises at the heart of our BHP campus (3.4.3).

### 1.7 Open Research

UoA1 is committed to a culture of open research and will play a leading national role in further defining the scope and importance (REF5a; 2.2). An academic lead has been appointed to ensure that the implementation of open science complies with, and exceeds, current recommendation by research funders and regulators.

In order to support *Open Publication*, all UoA1 staff comply with REF2021 requirements for open access. Central resources are used to support gold standard publication wherever possible. Researchers curate publications on the PURE information system with preprint 'accepted' versions archived in PURE and data shared as quickly as possible with the international community. UoB has contracts with many publishers to support Open Access and we are

signatories to the San Francisco Declaration on Research Assessment (DORA), emphasising quality of research rather than journal metrics, and use this for promotion and recruitment.

To support *Open Data* we make our data Findable, Accessible, Interoperable and Reusable (FAIR) and these principles are included in our research data policy. Storage facilities for research data are freely available and we encourage publication of full experimental details and open analysis codes. One example is recent work [on ethnicity and Covid-19 outcome](#); (“anonymised participant data and data dictionary defining each field will be available to others through application”).

### ***Future plans for Open Research***

- From 2021 a bespoke training course in Open Research will become mandatory for research staff and PIs will be expected to maintain an ORCID to ensure outputs are traceable and linked with their PURE account.
- UoA1 is a world leader in defining the evidence base for outcome measures for artificial intelligence in healthcare (**Denniston; Cat C**). *Open algorithms for data extraction* have been developed to extract data from large databases in a transparent and reproducible manner and we will encourage open source software systems to improve interoperability of algorithms.
- All researchers will have a minimum of 4TB of free server space to store research data, archived for 20 years.
- To simplify data archiving we will increase the use and useability of our research portal (PURE) to link publication with associated data and will work with academics to obtain consent from participants to release their anonymised data.

### **1.8 Research integrity**

Research integrity is a vital component of medical research embedded within our culture of creativity, freedom and integrity. The University has an established **Code of Practice** for all research-active staff which provides a clear framework and guidance on research integrity. The **Clinical Research Compliance Team** has been established to deliver support to external regulatory standards for researchers involving human participants, delivering training programmes and providing expert advice and guidance to researchers. The team works closely with the University's **Research Governance and Ethics** team to ensure UoA1 responsibilities are undertaken effectively and efficiently with commensurate ethical review. All studies involving human subjects are assessed by Institutional and external ethics panels and animal research is subject to internal review by a dedicated **animal ethics committee**. Our **Clinical Trials Oversight Committee** assesses compliance of CRCTU and reports directly to the UoB Research Governance, Ethics and Integrity Committee.

Potential allegations of breaches of integrity are of highest concern and the University has a defined process for investigation, supported by staff in human resources and legal services (REF5a 2.2).

## 2. People

### 2.1 Strategy

UoA1 recognises that people are the primary determinant of research success and works to ensure it represents a destination of choice (REF5a, 3.1). Our integrated staffing strategy embraces all career stages and reaches across non-clinical and clinical boundaries. Particular emphasis is placed on embedding processes that ensure optimal recruitment, support & development, as well as promotion & retention, thereby allowing staff to fully express their potential. In all areas we pay particular attention to equality, diversity and inclusion to make sure that we continue to support an inclusive and dynamic research culture.

Here we set out the developmental journey across all career stages, from postgraduate through early career and senior posts, embracing both fundamental science and clinical roles, outlining associated infrastructure and process support.

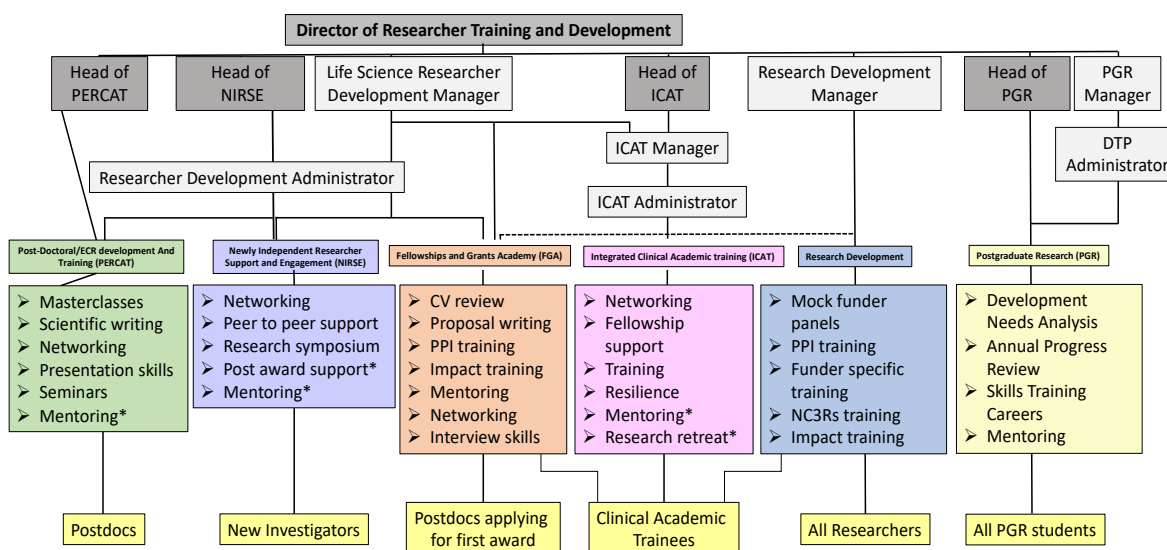


Figure 2.1. Overview of early-mid career development support structures within UoA1

### 2.2 Post-graduate researchers

#### 2.2.1 Internal and external investment

Since 2014 we have enrolled 1,111 postgraduate research students (PhD, MD, MRes and MSc by Research) with 455 current registrations within Uo1 (**Lead: Tennant**). The College has invested £6.8M over the current REF period to match studentships and nearly 100 funded studentships have been made available through our success in attracting prestigious doctoral training grants (Marie Curie ITNs, Wellcome DTGs, CRUK, MRC-ARUK, MRC DTG) and independent Clinical Training Fellowships. This has allowed the College to develop innovative training programmes for young scientists and clinicians. We have leveraged UoB-funded studentships to capacity-build in spheres of emerging strength such as global challenges. Our institutional MRC Doctoral Training Programme (MRC-DTP) is linked with the Universities of Nottingham and Leicester and matched 1:1 from internal funds, while our BBSRC DTP is joint with Nottingham, Leicester, Warwick, Aston and Harper Adams universities. UoA1 also benefits from a wide range of Charity-funded DRs (currently 34; sources include: Wellcome, CRUK, BHF).

The University of Birmingham is destination of choice for many international graduates. This adds further to our highly diverse PGR population, of which around 40% identify as Asian or mixed Asian and over 10% as Black or mixed background. We rank **1st in the UK as a coordinating Institution** for Marie Curie Initial Training Network (ITN) grants offering PhD exchange training. A dedicated Marie Curie Researcher Society supports our international fellows and UoA1 currently hosts 10 staff on Marie Cure awards.

### **2.2.2 Research training, skills development, funding and integration into research culture**

Interdisciplinary collaboration of supervisors is strongly encouraged and UoA1 hosts 158 postgraduate registrations with cross Institute/College supervisors. This is particularly important for national strategic collaborations associated with studentships offered by COMPARE, MRC IMPACT, BBSRC MIBTP, the MRC-Versus Arthritis Centre for Musculoskeletal Ageing Research (CMAR), Global Challenges and the Alan Turing Institute. Collaboration is enriched by the Doctoral Training Programme (DTP) symposium, the annual PhD Research Festival and PGR-led journal clubs which encourage open scientific discussion in a safe and nurturing environment.

UoB aims to become a favoured location for overseas PhD candidates and UoA1 has appointed a College Lead for International PhDs (**Lead: McGettrick**) and launched an Integrated PhD in Life Sciences programme for international postgraduates. This has generated significant interest and provides a high-quality research-based training scheme, integrating technical skills, analytical skills for quantitative or qualitative research, communication skills for diverse audiences and core transferable skills. The programme aims to enhance the student experience in a research-intensive University environment to create the next generation of global academic and life science leaders.

### **2.2.3 Training and development**

The College Graduate School ensures that, in addition to normal supervision and mentoring, students can enhance their personal development through bespoke generic and specific training covering topics such as statistics, entrepreneurship and experimental design. The PGR student completes, with their supervisors, an annual development needs analysis that assesses training needs, aligned to the Vitae Researcher Development Framework. Identified needs are supported through formal training programmes. The College and University Graduate Schools work closely to co-ordinate delivery of transferable skills such as communication, career development, publishing and thesis preparation. In addition, each discipline has its own specific skills training and research seminar programme which PGRs are required to attend and PGRs join the formal Institute seminar list in their final year of training.

### **2.2.4 Careers support**

An annual CMDS event focussing on 'Careers outside academia', and supporting CV and interview preparation, is held in collaboration with external speakers. In addition, our Careers Centre offers skills training courses designed to help postgraduates looking to find their niche in the jobs market. There are practical opportunities within UoA1 to gain an understanding of business and develop entrepreneurial flair at our CMDS Enterprise Summer School and undertake outreach activities in schools visits, shadowing, and co-developing activities and poster and oral presentations. Support is also available in talking to the media (mock TV and radio interviews) and social media awareness as well as patient and public engagement training platforms.

### **2.2.5 Monitoring and review**

All PGRs have access to a minimum of two supervisors and a personal mentor. Supervisors are appointed on the basis of research excellence and the ability to supervise and mentor students. A

tailored supervisor-training programme (for both new and established academics) continues to assure quality of supervision and includes equality and diversity training to minimise bias during recruitment. This is positively reflected in the diversity of our student cohort (2015-2019 intakes), which accurately reflects the gender identity of the undergraduate applicant pool (57% female), has higher than expected ethnic diversity (<60% identifying as 'white') and 7% reporting a disability.

UoB has a strong programme to ensure monitoring of PGR supervision (REF5a 3.2), including monthly supervision reports and an annual progress review by a progress panel with action taken as necessary. The review includes a formal written report submitted by the student and supervisor/co-supervisor and an oral presentation. Any concerns are managed by individual and joint meetings with students and their supervisor.

### **2.2.6 Wellbeing**

The 2017 PGR experience survey reported that 30% of UoA1 students felt the research experience had affected their mental well-being. In recognition of this we incorporated workshops and activities related to resilience, mindfulness and mental health awareness at induction and other student events. The College has established a PGR Academic Lead for Wellbeing (**Topping**) and a PGR Academic Lead for Mental Health (**Blair**). CMDS has a Student Services Centre where professional services wellbeing officers are available on a drop-in basis (Monday-Friday, 9am-5pm). Following consultation with PGR representatives, a CMDS 'PGR buddying' scheme was initiated to offer informal advice and signposting to available resources.

In addition, the Guild of Students has a designated postgraduate officer and offers a free and confidential service to PGRs in areas such as finance, housing, immigration and employment. UoB has also, in partnership with Forward Thinking Birmingham and the Children's Society, established the Pause Drop In Centre for confidential support and signposting (REF5a; 3.4.5). CMDS initiated a local response by piloting mental health first aid (MHFA) Awareness Training ([mhfa.org](http://mhfa.org)) in 2019 with 30 PGR supervisors. Success was such that it has been embedded as core training for supervisors, supported with group supervision facilitated by an MHFA trainer and emulated across the University.

The CMDS EDI committee has extended eligibility for the Parent and Carer's fund, which provides support with childcare/caring costs for those attending conferences, to PGR students. UoA1 has also instigated a new Student Equality Group (SEG), with staff and student co-chairs, to bring together existing student-related EDI work and support delivery of the targets and action plans.

## **2.3 Early Career Researchers (ECRs)**

### **2.3.1 Researcher support and Concordat**

We have put in place a range of activities to implement the *Concordat to Support the Career Development of Researchers*. Academic career development is supported by mentorship schemes, leadership development, coaching and courses offered by UoB People and Organisation Development (REF5a; 3.4.4). ECRs are encouraged to take responsibility for their own development and engage with development opportunities over a minimum of 10 days each year, as per the Concordat.

### **2.3.2 Career development and culture integration**



The College fosters a supportive environment for ECRs ensuring that they are represented on college committees. The Post-Doctoral/ECR development And Training (PERCAT) initiative (Lead: **Stamataki**) was set up to provide training and support for ECRs, driven by their active involvement. This includes masterclasses (e.g. Scriptoria for scientific writing, transferable skills workshops and resilience training), symposia, mentoring and career support with involvement from employers from different sectors. The aim is to deliver on the Concordat principle of enabling researchers to achieve their full potential. PERCAT distributes a monthly newsletter to 400+ ECRs and its priorities are informed by an annual ECR survey and coordinated by ECR representatives who are also members of the College Institute Executive Committees. The latest biannual Vitae survey on careers in research provided evidence of strong ECR engagement within UoA1, with clear progress between surveys in 2017 and 2019. For example, 84% agree/strongly agree that they are encouraged to engage in personal/career development and 89% taking ownership of career development. Dedicated professional careers advice for UoA1 academics is provided via bespoke PERCAT-coordinated external consultants.

### 2.3.3 Supporting pathways to independence

Pathways to independence for ECRs within UoA1 are supported by tailor-made career development programmes including the ***newly independent researcher support and engagement (NIRSE) programme*** for post-doctoral basic scientists and our Fellowship and Grants Academy (FGA) initiative (2019). We offer bespoke training including: CV review and advice from senior academics, funder-specific grant workshops, grant and fellowship clinics with senior researchers and interview skills training. All activities are supported by the researcher development manager and 161 people have engaged with the academy, with 45 applications submitted of which 10 have been funded, totalling £5.1M (e.g. Sir Jules Thorn, £1.7M (**Sinclair**) and Advanced Clinical Scientist CRUK fellowship £1.4M (**Shetty**)). Our FGA initiative will evolve to support ECRs managing their awards, with provision of post-award support and training on budget, career management and difficult conversations.

We have leveraged external institutional awards to support career progression. In particular, the major theme of our successful Wellcome ISSF award 2016-2021 was targeting of funds to promote career progression and support fellowship applications. The goal is to help researchers gain fellowships and to bridge difficult career transitions. We have supported 47 awards since 2016 of which 64% were to women.

### 2.3.4 Developing research interests in undergraduate medical students

We firmly believe that the future health of UK academic medicine depends on engaging clinicians with research from the very onset of their professional training and invest heavily in this axiom. Our MBChB degree promotes research experience through 'Research Tasters' in which students meet in small groups of 5-6 with a researcher and discuss current research to get a sense of what research is and how it works. In Year 2 students can undertake a 'Personal Interest Project' where they investigate a subject of interest in depth, under supervision of an expert, and get exposed to critical evaluation of evidence and formation of hypotheses. Students are also encouraged to undertake a custom-made summer school. Moreover, 35% of our MBChB. students take advantage of our wide range of intercalation options in areas of research excellence which provide a strong foundation for a research career.

#### 2.3.5.1 Integrated academic training pathway

Support for clinical ECRs is provided by our highly respected integrated clinical academic training pathway (Lead: **Boelaert**). Since inception this has been awarded 170 NIHR ACF posts and 73

NIHR ACLs, with 90% in UoA1. 159 trainees have completed training and 75 of 112 ACFs (67% vs. national average 47%) have progressed to clinical research training fellowships or other academic posts and 37 of 47 NIHR ACL have progressed to senior academic positions (79% vs. national average 69%). Birmingham is in the top 25% of institutions for NIHR-funded training posts and strategic funding decisions by the College have maintained 9 ACFs and 51 ACL locally-funded posts. All trainees are provided with a consumable budget beyond support provided by NIHR. A monthly newsletter is sent to all trainees communicating and encouraging attendance at training events. An annual trainee survey is conducted annually to inform future training events and assess satisfaction with 100% rating training as ‘good/excellent and relevant’ and 90% rating academic supervision as ‘good/excellent’.

Trainees are encouraged to access interdisciplinary training opportunities and co-localising clinical trainees with non-clinical scientists facilitates these opportunities. Examples include the Healthcare Technology Institute where ophthalmology trainees are co-supervised by engineers on innovative solutions to prevent corneal scarring and neurosurgeons co-supervised by neurobiologists in the NIHR SRMRC.

Over 90% of trainees feel they are provided with sufficient resources, opportunities, advice and support in relation to achieving their academic goals and academic career progression.

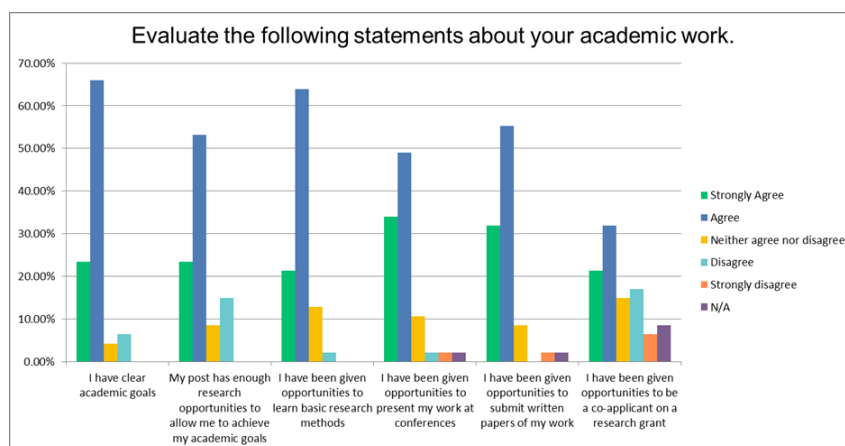


Figure 2.2. Responses to Clinical Trainee survey report 2019

Our Academic Foundation support has established a reputation for excellence and 70% of students are offered posts, compared to national average of 51%. 32% of applicants come from other universities and 98% of appointees report Birmingham as their first choice. Clinical academics often rate a positive experience or engagement with an inspirational researcher as the important first step in developing a research interest. Our **INSPIRE** scheme (funded by Academy Medical Sciences) has funded 33 summer studentships over the assessment period, supported travel to conferences for 57 students, provided networking events and dinners and showcased research excellence with the development of a distinction in research award annually.

In addition, working in a unique way with our NHS Charity partners, we have established a **BHP Fellowship** scheme, which provides salary for 1 year to allow clinical trainees to develop preliminary data for competitive fellowship applications. This has appointed 18 fellows since 2015 of which 60% have progressed to external competitive fellowships with grant income totalling >£2.5million.

### 2.3.5.2 Clinical Doctoral Training

250 clinical trainees have completed a higher degree over the assessment period, 60% funded through highly competitive personal fellowships. A survey of these trainees (59% response rate) suggested 95% would recommend the experience, 77% had 3+ publications, 85% continued to participate in research following completion of their degree and 82% reported the experience improved their provision of clinical care. UoA1 provides a range of funded PhD opportunities for clinical staff. As one example, the Birmingham CRUK Centre Clinical Academic Training and Research Programme has recently been expanded to annually train 3 MB-PhD students to start PhDs at completion of intercalation as well as 3 Clinical Research Training Fellows. A similar scheme was recently successful in funding from the Kennedy Foundation for rheumatology research.

### 2.3.5.3 Bridging support to achieve research independence

A critical stage in the career of academic clinicians is the development towards academic independence. In 2017 we introduced a systematic support approach for Academy of Medical Sciences Starter Grants for Clinical Lecturers which raised success rates from 16% to 50%. These grant holders are considered as independent researchers and are included in REF submission. NIHR recognise the importance of bridging this gap and support trainees to continue their CL post beyond completion of clinical training (CCT). In a unique partnership with our local education and training board, we have matched the NIHR offer and all our CLs have the opportunity to extend their post-doctoral training for 1 year following CCT (2019).

### 2.3.5.4 EDI

Transition to independence is particularly challenging for women as it often coincides with changing family circumstances. In Autumn 2016 we introduced the Athena SWAN Parental Leave Project Support Grant for Clinical Lecturers which funds technical support (up to £20,000) to support project continuation, with 4 awards made to date. An important partnership also exists with the Mayo Clinic in the U.S. to support clinical ECRs to develop independence and international networking via an exchange programme. 7 individuals have been supported across 4 clinical disciplines, resulting in several joint publications.

### 2.3.5.5 Support for non-medical clinical academic careers

To meet evolving healthcare demands it is essential that the wider clinical workforce is supported to engage in research. Working with NHS Trust partners, we successfully secured £1.1M from Health Education West Midlands to **support non-medical clinicians** who wish to embark on a clinical academic career. This offers an introduction to research including research design, data management and practical research. 100 staff have completed the programme and 90% strongly agreed the programme was helpful. Impact was demonstrated by both participants and managers identifying organizational benefits of participation, including increased use of evidence-based practice. Metrics of success have included award of 7 NIHR doctoral fellowships (from 11 submitted vs 1 in the 5 years prior to start) and 7 pre-doctoral clinical academic fellowship awards (from 12 submitted with 10 judged 'fundable', the best rate in country). 40% of participants received additional research funding or progressed to further study and >100 articles have been published and 26% of participants promoted (2016-18).

### 2.3.5.6 Evidence of success

These initiatives have contributed to our outstanding success in supporting clinical researchers of all career stages in obtaining prestigious personal fellowship support. Since 2016, 45 early career

researchers were successful in securing prestigious personal fellowships or New Investigator awards (e.g. MRC, Wellcome, NIHR, CRUK, BHF, Versus Arthritis), including 16 fellowships to support clinical academics. Additionally, 8 Mid-career and Senior fellowships and 13 NIHR Senior Investigator Awards have been gained. Over 50% of our CLs have been awarded intermediate/senior fellowships and 10 have progressed to appointment in Professorial positions.

## **Academic Staff (Teaching and Research)**

### **2.4.1 Investment context**

259 staff within UoA1 were considered eligible for REF21 and 231 are submitted after consideration of research independence according to UoB REF21 guidelines. Research-only staff numbers have increased by 26% between 2014 and 2020, rising from 500 to 630, reflecting a substantial increase in the research base.

### **2.4.2 Recruitment strategy**

An ambitious recruitment programme has been implemented and during the assessment period we have recruited 20 Chairs, 7 Readers and 10 Senior Lecturers. These initiatives include the Birmingham Fellows and Industry Chair campaigns (REF5a; 3.4.1). In particular, Lewis brings 30 years global Health industry experience and is currently Chair of 5 Medical/CRO/digital health companies, supporting our ambition to expand industry links. Our Interdisciplinary Professors have included **Owen** and **Metcalfe** in Chemical Engineering and a £7M investment to recruit **Terry** to lead a new Centre for Systems Modelling & Quantitative Biomedicine with Mathematics and Computer Science.

UoA1 aims to attract the best international talent and **Calebiro** is an exemplar, appointed through our Professorial Fellowship scheme and recently awarded a Wellcome Trust Senior Research Fellowship. Integration of international staff is supported by tailored induction and welcome packs, regular meetings, surveys and focus groups. Personal support is further provided by current staff members acting as 'buddies' to new staff from overseas. Recruitment is always focussed on strategic priority, building on local strength and promoting interdisciplinary outcomes, e.g. Herten, recipient of an Academy of Medical Sciences professorship. Section 1.2 highlights examples of recruitment to build critical mass in key areas of development.

### **2.4.3 Induction and Performance Development Review (PDR)**

A new schedule for Induction has been implemented centrally (REF5a, 3.4.2) and UoA1 has developed this further for all new staff, capturing initial support, training and signposting to the wealth of resources available. All staff undertake an annual PDR conducted by managers who receive bespoke tuition, including unconscious bias training, and emphasis is placed on career development.

### **2.4.4 Training and Leadership Development**

The scale of investment and quality of research leadership training at UoB is amongst the strongest within the HEI sector (REF5a, 3.4.5c). An extensive range of opportunities are provided through the **People and Organisational Development (POD)** team (REF5a, 3.4.3b) to support the development of UoA1 leadership, strategic influencing and networking capabilities. Training and development opportunities include accredited and bespoke immersive programmes, consultant-led sessions and webinars such as action-centred leadership, resilience, wellbeing and

managing change and ambiguity. All staff have access to UoB **LinkedIn learning license** for co-directed learning.

Leadership programmes include:

- **Senior Leadership**: for grade 10+ staff, designed to empower strategic leadership in times of rapid change – 22 UoA1 staff (32%F) have attended.
- **Emerging Leaders**: for grade 9 staff, focussing upon the relationship between leadership and management and models of effective leadership- 35 UoA1 staff (49%F) have attended
- **Research Team Leaders**: for *early* career researchers with aspirations to lead their academic field and become an effective team leader. This is a well-established collaboration with the University of Nottingham – 18 UoA1 attendees (50%F).
- Many UoA1 academics (e.g. **Mauro, Sapey, Calebiro**) have also taken advantage of the UoB **Research Leaders** programme for mid-career academics (REF5a; 3.4.4).
- **ILM-accredited Leadership and Management Levels 2,3,5**: for Academic and Academic-Related staff wishing to develop a firm management foundation (level 2) - 53 UoA1 staff (79%F)
- **Aditi Leadership**: for Black, Asian and Minority Ethnic (BAME) academic and academic-related staff in the University; 8 UoA1 staff (50%F) have attended.
- **Aurora**: for ECR female academics. This is Advance HE's leadership initiative for women and those who identify as women, bringing together leadership experts to address under-representation of women in leadership positions in HEI. 24 UoA1 staff have attended.
- **MDS SUSTAIN**: a new programme for ECRs establishing their own research group, a unique partnership with the Academy of Medical Sciences, modelled on their national SUSTAIN programme for female early career leaders. Our programme will widen participation beyond gender (e.g. ethnicity, LGBT, first generation scholars) to ensure better future representation at senior academic level.

UoB has an established **coaching academy** with experienced coaches that understand the work environment and the challenges it presents. To date 56 staff from UoA1 have received coaching (77%F). Managers who wish to become qualified can join the University Coaching Academy by undertaking the ILM Coaching and Mentoring programme. **Denniston** and **Sapey** have joined the prestigious external NIHR FLIER (Future Leaders in Innovation, Enterprise and Research) programme for which **Adams** sits on the cross-sector Task Force.

#### 2.4.5 Promotion, rewards and recognition

UoA1 has championed transformational change in **support for staff through the promotion process** at all stages. Early support is given to those we feel could be on a trajectory for promotion, and colleagues who are unsuccessful receive support, feedback and mentoring to help them focus on closing any gaps to improve future success.

We believe that our excellent rates of retention and promotion have also been enhanced by significant improvements to our Performance Development Review (PDR) process. Since 2019 we have introduced Institute-specific PDR review committees to identify and encourage candidates for promotion and we have also made it a requirement for the College EDI lead to join the senior promotion committee. These steps have helped to achieve substantially higher success rates for female academics, achieving 63% and 53% of the reader and chair appointments, respectively, since 2017.

To further help embed these process improvements consistently across the College in 2020 we introduced the role of Institute career development leads to support staff applying for promotion. As a result of our efforts in these areas, through staff surveys we were delighted to see an increase of satisfaction in the PDR process of 53% from 2018 to 2020, and a concomitant increase in satisfaction in the academic promotion process of 54% over the same period.

## 2.5 Career support for development and delivery of impact

Our infrastructure, practice and processes to support engagement with external stakeholders is covered in Section 4. Specific career-linked opportunities for engagement include:

- Recruitment of **Campbell-Hill** (10 years founding member of the Medical Technologies Advisory Committee for NICE and recent Non-Executive Director for MHRA) to develop entrepreneurial training programmes.
- Recruitment of **Lewis** as Professor of Life Sciences Innovation.
- Links to staff in major advisory roles within business and charity bodies, such as **Kearns** who is Trustee at CRUK.
- DTPs include support and training for students to spend dedicated time delivering public engagement activities or external policy roles (4.2).
- International engagement is supported by a range of opportunities.

## 2.6 Equality, Diversity and Inclusion (EDI)

EDI is at the heart of UoA1 strategic vision and is driven by the **College EDI leadership team** which comprises leads from Institutes and professional services and reports to College Board and the University Equality Committee. This team is supported by a dedicated EDI Officer since 2018. This team ensures that relevant activity is embedded as a behavioural and cultural norm and provides support to researchers through promotion of diversity activities, signposting staff and students to appropriate policies and services, exploring equality related barriers that may hinder any member of staff or student being successful, providing scrutiny for policy and strategy development and implementation, and providing an advocacy role for implementation of policy and delivery of plans.

Examples of targeted interventions to improve awareness of EDI and close notable gender and ethnicity gaps at different levels across the College are present throughout this document (e.g. 2.2.1, 2.2.5, 2.2.6, 2.4.2, 2.4.5, 3.3). A recent survey of staff demonstrates the notable improvements in this area and the impact our positive interventions have made. Survey findings reveal that, between 2018 and 2020, there has been:

- 60% increase in respondents to communications relating to EDI;
- 46% reduction in behaviour respondents would describe as 'discriminatory';
- 54% increase in satisfaction of the academic promotion process;
- 53% increase in satisfaction of the PDR process.

We are pleased to see improvements, not only in perceptions of gender equality, but also in tangible outcomes, such as the improved prospects of promotion for female academics which supported our successful Athena SWAN Silver award in 2020.

However, EDI is about more than gender equality. We recognise the particular barriers that BAME staff can face in accessing and maintaining success in the College and which are evidenced through under-representation of our BAME staff at Professorial level. We remain committed to open communication with our staff and students about the issues they face, as well as increasing collaboration with our NHS partners to address any issues identified and proactively work to foster

an inclusive atmosphere across our organisations. The **College EDI Committee** includes staff network representatives representing women, BAME, LGBTQ, disabled, and parents/carers.

Since 2018 we have created a **race equality working group** and sponsored and co-organised two Black History Month and one LGBT History Month conferences at University Hospitals Birmingham. We also hosted the LGBT STEMinar conference (2019). Internal events for Black History Month and LGBT History Month have been supplemented with 'Bring Your Family to Work Day' and 'World Menopause Day'.

We also recognise that we will be able to create more impactful and lasting changes by working collaboratively with regional partners. Professor Una Martin (ICS and former Deputy Pro-Vice-Chancellor, Equalities) has joined the **Inclusive Leadership forum** established by the Mayor of the West Midlands, Andy Street, committing the University to three pledges around female representation at Senior Leadership with emphasis on BAME representation.

We have prioritised consideration of Equality, Diversity and Inclusivity issues in constructing our REF submission, following the University's Code of Practice for REF2021, including the use of equality impact assessments in both the process of identifying staff with significant responsibility for research and those who are independent researchers, and the final selection of submitted outputs. Equality impact assessments, overseen by the College Director of Research, compared the contributions of staff with protected characteristics and at different career stages to the submitted output portfolio with their representation in the UOA1 as a whole. Our submission reflects the diversity of UoA1 research and our equality impact assessments show no evidence of biases with respect to any particular cohort of combination of protected characteristics.

### 3. Income, infrastructure and facilities

#### 3.1. Research Funding Strategy

Research funding strategy is planned and delivered through the College Board. We aim to deliver a balanced 'bench to bedside' research portfolio from a variety of funders including UKRI, NIHR, charity, international and industry. This strategy has seen UoA1 research awards increase by 49% between period 2013-2016 and 2017-2020, from average £43M to £64M per annum.

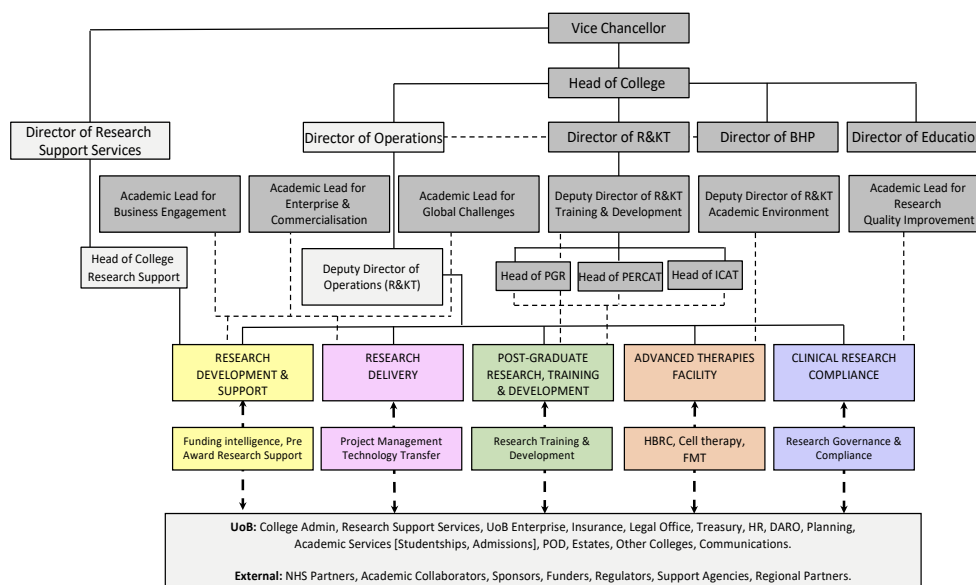
Key drivers of our strategic delivery include:

- Strengthening **interdisciplinary research** through collaborative Centres such as our Centre for Computational Biology (UoAs 1, 11 & 24), Centre for Patient-Reported Outcomes Research (UoAs 1, 2, 18 & 20), Centre for Systems Modelling & Quantitative Biomedicine (UoAs 1, 10 & 11) and Medical Devices Testing & Evaluation Centre (UoAs 1-3 plus 8 & 12).
- Support for **large consortia awards**, through strategic partnership posts and a cross-cutting project management teams. This has delivered several major awards such as our CRUK Centre, NIHR BRC, NIHR/CRUK ECMC, Innovate UK MW-ATTC, Birmingham-Oxford A-TAP, HDRUK Centre and PIONEER HDRUK Hub.
- **International links** have been transformed through a number of collaborative initiatives including the *NIHR Unit in Global Surgery*, a Global Health Group in COPD and our WHO partnership delivering the e-MOTIVE study funded by the Bill & Melinda Gates Foundation. The number of **outputs with an international partner has increased by 60%**, from 392 in 2014 to 627 in 2020.

- The capacity and breadth of **translational research** awards has increased substantially over the last 5 years. We have increased capture of MRC Confidence in Concept awards and been funded at increasing levels over seven consecutive rounds. We have also been successful in three rounds of MRC Proximity to Discovery funding, winning a Wellcome Trust Translational Partnership Award in 2019 (£600K), appointing an Entrepreneur in Residence and external consultants to de-risk projects in ‘Dragons Den’-style discussions for IP and spin-out companies.
- Investment in **Business Engagement** professional services staff and establishment of a culture of knowledge exchange across UoA1 has delivered a steep upward trend in industry awards from £4M (2014) to £15.2M in 2019, of which £11M came from global pharma. Over the last 12 months, 79 UoA1 researchers delivered research projects with industry, with many more being engaged in the development of project ideas and relationship-building with companies. We are proud that 6.5% of UoA1 outputs now include a corporate partner.
- Engaging all academic staff in **strategic development** and established ‘think tanks’ of academics who sit on national research committees to inform UoA1 research strategy.

### 3.2 Operational research infrastructure

The research and knowledge transfer management structure within CMDS is based on integrated leadership by both Academic and Professional Services staff (see figure 3.1).



**Fig 3.1 Operational research infrastructure within Research and Knowledge Transfer (RKT)**

The above structure brings together a team of 90 staff working on grant development and delivery, regulatory compliance, research integrity, translation and researcher training. These link to University-level teams covering Business Engagement; Strategic Projects; Charitable Funding; Interdisciplinarity (Institute for Global Innovation); Commercialisation (UoB Enterprise); External Relations (including Public Engagement with Research); International Collaboration; and Research Finance.



Specific UoA1 teams include:-

- The **Research Development and Support Team** of 9 staff who support the development and submission of grant applications and have established a 'Grant Information Centre' to provide enhanced support to grant applicants.
- The **Strategic Projects Team**, a newly-established team of senior professional services staff who develop major research investment opportunities, particularly those involving highly interdisciplinary and cross-sector partnerships. Notable successes include the two HDR Hubs and £6M DEMAND Hub SME platform in collaboration with the School of Engineering.
- The **Research Delivery Team** of 44 staff comprises project managers developing and managing large consortia and infrastructure bids. They provide expertise and training in specialist areas including PPIE and translation and the management of grants e.g. MRC Confidence in Concept and Wellcome Trust Translational Partnership.
- **Technical and Facilities support** delivered by 50 core staff in technical roles, with additional 70 funded from research grants. UoB was early signatory to the national **Technician Commitment** for recognition, career development and sustainability (REF5a; 4.4). We launched our Technical Academy in 2017, improving skills training, networking and career structures for all technical staff. We hold technical conferences and have supported attendance at the national Higher Education Technicians Summit, hosting in 2019, and supported the Science Council on their Professional Registration Scheme.

### 3.2.1 IT Infrastructure

The University has made three major recent investments in data support including the largest IBM AI cluster in the UK (REF5a; 4.5). Additionally, within UoA1 the **Compute and Storage for the Life Sciences (CaStLeS)** is a £2.3M investment, with 5Pb of storage, 122 Compute Nodes and eight IBM Power9 with GPUs, which has propelled Birmingham to the forefront of AI and Data Sciences for the Life Sciences. This unique resource of high performance cluster and virtual machines is used by 448 users across 102 projects, with support from two dedicated system administrators and a Research Software Engineer.

### 3.2.2 Laboratory space

Since 2015 we have undergone major reorganisation of research space to bring dispersed activities into physical proximity. The Institute of Biomedical Research underwent £18M refurbishment in the West Wing Extension which increased the provision of high quality laboratory space by 3000m<sup>2</sup>, and provided bespoke accommodation for our core imaging facilities including light microscopy, COMPARE and intravital imaging. ICGS was previously split across five locations, but following an £8.8M investment is now housed in a single area which opened in January 2020. We are currently investing £1.3M in our molecular NMR facility to accommodate an EPSRC-funded 1GHz NMR Spectrometer which was delivered in 2020.

### 3.2.3 The Technology Hub and key research facilities

- The **Technology Hub** comprises a wide range of state of the art research facilities including Imaging Suite, Genomics Birmingham, Flow Cytometry and Sorting, Protein Expression Facility and Category 3 Containment. £13.5M investment in strategic equipment supported expansion of Genomics into nextSeq500, single cell sequencing and promethion long read sequencing. We have confocal, 2 Photon & TIRF microscope imaging. Our immunophenotyping core includes a Helios CyTOF Mass Cytometer. Tech

Hub facilities are overseen with by academic leadership, a dedicated manager, Stratocore® booking system and 14 staff (seven new since 2017).

- The **Human Biomaterials Resource Centre** is a Human Tissue Authority (HTA) licensed human sample biorepository which is dedicated to the collection and storage of appropriately consented, quality-assured biomaterials for distribution to biomedical research groups both in academia and industry.
- The **Cell Therapy Suite** is a clean room facility licensed by both the MHRA for the manufacture of Advanced Therapeutic Medicinal Products (ATMPs), and the HTA for the production of cell- and tissue-based therapies for human application. The main objective of the CTS is to enable, embed and facilitate clinical research projects and programmes involving the delivery of gene and cell-based therapies.
- The **Microbiome Treatment Centre** is the first Medicines and Healthcare products Regulatory Agency (MHRA) licensed facility in the UK to provide Faecal Microbiota Transplant for clinical trials and for the treatment of patients with recurrent and refractory *Clostridium difficile* infection.
- The **Centre for Computational Biology** (est. 2014) is a joint initiative between CMDS and the College of Life & Environmental Sciences, and has leveraged in excess of £35M grant funding building on UoB membership of the Alan Turing Institute.
- The **Biomolecular NMR Facility** is the largest open access high and ultra-high field NMR facility in the UK. In 2018, UoB was awarded £6.5M investment (UKRI/EPSC) for 1 GHz spectrometer offering the highest field strength and line-up of NMR spectrometers at a single site. A £1.5M Wellcome Trust award supports UK-wide open access, acting as national high field centre alongside UoA1 research in NMR tracer-based metabolism and metabolomics for translational medicine.
- The **Phenome Centre Birmingham** is a collaborative fee-for-service centre, supporting untargeted and targeted metabolomics and offers capacity to perform 30k liquid chromatography-mass spectrometry and 15k NMR assays /year.
- The **Biomedical Services Unit** (BMSU) provides facilities for the breeding and maintenance of small animals (12,000 rodents in IVC caging) and zebrafish (600 tanks, 10,000 fish) as well as infrastructure for investigational procedures including live imaging and operation rooms.
- The University leads one of six HDRUK sites in the Midlands HDRUK Centre (Leicester, Nottingham and Warwick). Success was facilitated by **Gkoutos**'s recruitment as Professor of Clinical Informatics. In 2019 we won two of seven national HDR Hubs focussing on acute care (PIONEER) and ophthalmology (INSIGHT).

### 3.3 Equality and diversity

The College was awarded Athena SWAN Silver status in 2020 and has delivered a comprehensive and innovative range of activities, refreshed and changed policies, and taken practical steps to improve the working environment. Funds are available to help with childcare costs during conferences and a budget is set aside annually to fund SWAN events. Staff can access a range of leadership opportunities and are offered grant workshops and fellowship interview practice. We have further identified that women are more likely to apply for grants only when they feel they “tick all of the boxes”, are very well prepared and the likelihood of their failure is low. To provide suitable support the College provides seedcorn funding and mentorship for female early career researchers through our Research Development Fund, showing increasing success rates for female applicants since 2014.

Our ***Fellowship and Grant Academy and Newly Independent Researcher Support and Engagement*** initiatives provide an excellent space for cohort support, exchange of ideas and peer help, which is very important to ensure women do not feel isolated and left on their own. Fellowship Academy events are well attended by women (61%F) with the result that in the last year 65% of applications submitted by FGA attendees were from women and 78% of the applications funded were awarded to women. 52% of our New Investigators that have signed up to NIRSE events are women.

Staff have access to a dedicated breastfeeding/expressing room, multi-faith prayer space, and gender neutral toilets in our main building, which are accessible from all of our laboratory facilities; similar facilities are available in our partner hospitals.

### **3.4 Infrastructure for impact**

A significant proportion of our infrastructure, facilities and expertise are focused on delivering impact and this integrated approach across stakeholders is driving innovation for patients and communities.

#### **3.4.1 University Impact Infrastructure**

The focus of our impact infrastructure is the ITM, established in 2016, as a £24M (£12M matched from BEIS) research facility that acts as a central hub for interaction between basic scientists, clinicians, informaticians, biostatisticians, bioengineers and clinical trial design experts and industry. The aim is to accelerate clinical therapeutic innovations. The ITM hosts the £7.2M West Midlands MRC/Versus Arthritis Stratified Medicine Facility (deep immunophenotyping, molecular pathology, metabolomics), Clinical informatics, Centre for Patient Reported Outcome Research and two trial management teams supporting trials into drugs, advanced cell therapies, biomarkers and devices. The ITM Novel Endoscopy Centre, located at the NIHR-Wellcome CRF, houses the latest endoscopy equipment with magnification and optical enhancement and confocal endomicroscopy *in vivo*. Further services include device simulation facilities, the first robotics pharmacy dedicated to clinical trials and research imaging facilities (COBALT). This facility is now at capacity and further translational ambitions will be expanded through the Birmingham Health Innovation Campus (3.4.3).

#### **3.4.2 NHS Impact Infrastructure**

The BHP alliance (see section 4) has co-created a shared vision for delivering transformational change at a local, regional and national level. Our Genomic Medicine Centre is an exemplar that links 17 regional NHS Trusts, accelerating service innovation and transformative research. As a result, we were the highest recruiting region for the 100,000 Genomes Project and co-developed a Genomic Tumour Advisory Board model, enabling identification of patients in novel trials for genetic mutations.

**BHP** coordinates our local NIHR infrastructure, ensuring an integrated translational pipeline from the BRC and ECMC, through to ARC and the Academic Health Sciences Network. BHP engagement was also critical to award of the Midlands HDRUK Centre and the MW-ATTC. It is also an integral part of the emergent Birmingham and Solihull Integrated Care System, playing a critical role in accelerating deployment of evidence-based interventions to transform the health and economic wellbeing.

Our jointly-managed **NIHR Wellcome CRF**, based at the QEH and BWC, provides high-quality clinical environments for experimental medicine, complex research studies, and early phase clinical trials, including an Advanced Therapies Facility and Inflammation Research Facility, plus the first stand-alone children's facility in the UK. It received the **largest UK award, £12.6M in 2016**. The CRF also hosts the **Birmingham NIHR Bioresource for Common and Rare Diseases**, the 2nd highest recruiter to UK rare disease cohorts. The work of the CRF covers high profile studies (e.g. gene therapy for haemophilia A) with implementation in healthcare (therapy for chronic HCV infection in children). With 450 active studies in 2017/18, it is the 3rd highest recruiter in England to experimental medicine CRF-based studies and with cutting-edge facilities including the country's first research pharmacy robot and specialist endoscopy equipment.

### 3.4.3 Industry Impact Infrastructure

A number of facilities have been developed to support UoA1 Industrial impact:

- **BioHub Birmingham** is a £9m bioincubator opened in 2015 to house and support spin-outs from the University and across the region. Four spin-out companies have been established in the reporting period (Revitope, Chimeric Therapeutics, Invex Therapeutics, MicrobesNG) with £16million development funding secured and 54 patents filed relevant to UoA1 during the current REF assessment period.
- To further capitalise on successes pioneered at BioHub and ITM, we have engaged Bruntwood SciTech in a long-term partnership to develop the **Birmingham Health Innovation Campus (BHIC; Fig 3.2)**. This will provide 675,000ft<sup>2</sup> for innovation facilities and commercial grow-on space on a 10 acre site at the heart of the University-NHS campus. £70M is being invested (UoB, Bruntwood, LEP) in phase 1, completing in 2023. The site will attract >£200M private investment for project completion in 2031. This will provide a home for innovative life and health sciences businesses seeking to co-locate at the heart of the BHP ecosystem. BHIC's key differentiator from similar incubator developments is the Precision Health Technologies Accelerator, an innovation hub supported by funding from the Greater Birmingham and Solihull LEP, which integrates genomics medicine & diagnostics, clinical trials, medical technologies and healthcare data to accelerate the delivery of healthcare innovations around early diagnosis and precision medicine.



**Fig 3.2** Artist impression of Birmingham Health Innovation Campus

### 3.4.4 Policy Impact Infrastructure

A dedicated University Public Affairs team facilitates significant interactions at a regional and national level with MPs, ministers, government bodies and other influencing functions. Within

UoA1, we have hosted a range of government delegations including Jeremy Hunt, Matt Hancock, Greg Clarke, Lord O'Shaughnessy and Baroness Blackwood. We hosted the national Life Sciences Industrial Strategy launch by Sir John Bell, and are one of only four sites in the UK to have official MoUs with the Association of British Pharmaceutical Industries and Association of British Healthcare Industries. We support academic engagement in policy, such as **Moss** who leads the £18M Immunity theme for the Covid National Core Studies programme.

#### 3.4.5 Impact Infrastructure for public and patients

Transport links into our campus are outstanding and will be further developed by UoB investment to **upgrade the University railway station**. This mainline station, busier than many city centre stations, is a 2 minute walk from the Medical School and five minutes from the QEH.

We have developed a team of professional patient involvement specialists who support numerous major infrastructure projects including our NIHR and HDRUK infrastructure, the Wales and Midlands ATTC, CRUK/ECMC and UK SPINE CCF award on healthy ageing with the University of Oxford. These specialists work as a coordinated team with our NHS partners to develop and implement a clear strategy across BHP which embeds the patient voice in the heart of our research. Our NCCPE Silver Watermark Award for public engagement with research had significant coordinating support and input from UoA1-associated staff.

#### 3.5 Evidence of cross-HEI shared or collaborative use of research infrastructure including the use of major research facilities both in the UK and overseas

Our Technology Hub links into the **Midlands Innovation group** of Midlands universities (Birmingham, Leicester, Loughborough, Nottingham, Warwick, Keele, Cranfield and Aston), a collaborative network working to improve research collaboration and share equipment and expertise. This is achieved through the Midlands Innovation equipment catalogue, joint training initiatives and a Technical Skills Placement Programme. For example, UoA1 researchers can access partial funding to utilise the high-spec cryo-electron microscopy housed in Leicester and shared flow cytometry technologies. Midlands Innovation Health was established by the same group of universities to focus on health issues and has supported pan Midlands initiatives including the Midlands HDRUK hub and collaborative working and access to shared facilities at the Defence and National Rehabilitation Centre at Stanford Hall. MIH is supported by the Midlands Engine and works closely with the Midlands Health Alliance lead by the three Midlands NIHR BRCs which coordinates collaborative working between the Midland's NIHR infrastructure.

A strategic partnership between the Universities of Birmingham and Nottingham co-invested £10M in the **COMPARE** in 2015, supporting shared state of the art microscopy facilities on both campuses, joint training programmes and research collaborations.

In 2017 we established an interdisciplinary **Institute for Global Innovation** to focus on pump-priming research with the Global South. The Institute has facilitated interdisciplinary dialogue across Colleges, Schools and disciplines and supports collaborative working with colleagues from around the world (REF5a; 2.3.3).

The newly purchased and refurbished city centre building **The Exchange** will be a hub for public engagement, focussing on making research accessible to the public in line with our civic mission (£40M investment; REF5a; 4.2.2). This will also house the new £5m research institute **West Midlands REDI** (funded by Research England) examining how research can directly inform policy

at the regional level, with major case studies planned around UoA1 medical technology research and commercialization.

### 3.6 Significance of major benefits-in-kind (including, for example, donated items of equipment, sponsorships secured, or other arrangements directly related to research).

Our **Development & Alumni Relations team (DARO)** supports regular giving and major gifts programmes aiming to encourage individuals, alumni, and trusts and foundations to support the University through philanthropy. This support has provided donations including Chair endowments (Versus Arthritis), £1M development of the Bladder Cancer Centre and equipment for the ITM (£200k). A key example of targeted endowments is the 'Birmingham Mayo Fellowships' which allow researchers to undertake fully funded extended visits to the Mayo Clinic in the US. The recent Birmingham in Action campaign focusses strongly on UoA1 activity, especially cancer. We have agreements in place with equipment suppliers who provide demo and prototype development. Pentax & Olympus have provided £500k each for advanced equipment 'in kind' to support endoscopic studies. We have also developed novel patient-focused models of philanthropic investment through clinical trials networks such as IMPACT, A-TAP and 'Rare Diseases TAP' which allow patient access for new drugs and have secured >£21 million industry investment.

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

### 4.1. College/institutional support to enable local collaboration

- The 2011 decision to develop BHP has facilitated greatly the integration and expansion of research strategy and collaborative activities over the REF period by UoA1 and its NHS partners, University Hospitals Birmingham and Birmingham Women and Children's NHS Foundation Trusts. The appointment of Dr John Williams as Managing Director in 2016 has leveraged a step change in research capacity, delivery and impact between stakeholders.



**Figure 4.1 The Birmingham Health Partners campus**

- With joint location on the Edgbaston campus (Fig 4.1), BHP offers a unique ecosystem which enables the full spectrum of translational medicine. BHP has a unified vision for "ageless" delivery of research with clinical and economic impact. This refreshed research strategy has resulted in substantial growth of inter-institutional awards, with NIHR

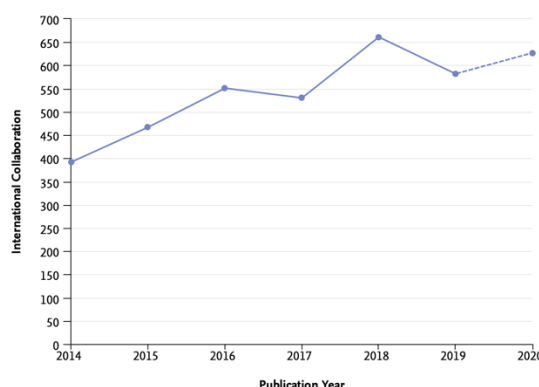
infrastructure bids growing from £21M in the last REF period to current value of £38M. The next investment into this unique integrated health campus is the **Birmingham Health Innovation Campus** which will deliver significant space for precision medicine and closer working with industry partners (Figure 3.2).

- The ITM (est. 2016) is a dynamic platform promoting collaboration and engagement between University staff, clinicians and industry (Section 3). This hosts academic, corporate and patient groups and supports laboratories, clinical trials teams (3.4.3) and medical device companies. It acts as a hub to promote collaborative problem solving between clinical academics and health professionals with bioinformaticians, biostatisticians, trialists, bioengineers and laboratory scientists.
- We have invested heavily to support translational activity through working with industry. A key example is BioHub Birmingham (Section 3) which houses University spin-out companies. There has been significant investment in business engagement through a dedicated Business Engagement Team of four staff for UoA1 along with core support posts (contracts/communications/marketing/events) who support academics in their engagement with industry partners. The UoA1 Business Engagement (BE) team sit within the larger UoB BE of 23 staff that allows further reach across the University to enable and facilitate cross-College, interdisciplinary collaborations and research.
- We use a broad range of internal and devolved external funds to pump-prime **new collaborations** across the academic, NHS and industry sectors. These include MRC Confidence in Concept and Proximity to Discovery awards, Wellcome ISSF and Translational Partnership, and UoB Enterprising Birmingham Funds. Notably, MRC investment of £4.6M has leveraged over £28M in follow-on funding, enabling significantly greater levels of translational activity through close working with industry partners.
- Regionally we have developed coordinated partnerships to drive research collaborations. We work through the Midlands Innovation Health group (connecting medical leadership across the universities of Aston, Birmingham, Keele, Leicester, Loughborough, Nottingham and Warwick) as well as the Midlands Health Alliance (connecting NHS and academic leads across NIHR-funded infrastructure in Birmingham, Leicester, Nottingham and Warwick) to develop joint strategic approaches to emerging national priorities, funding initiatives, patient/public involvement and training. Investment with University of Nottingham developed the £10million COMPARE initiative and MRC-ARUK Centre for Musculoskeletal Ageing Research.
- The University opened the Edgbaston Park Hotel and Conference Centre in September 2018 to support academic networking and attract national and international conferences. Several international UoA1 meetings, such as the 2020 European Young Endocrine Scientist Conference, have been booked to date although disrupted by the COVID pandemic.
- We actively support academics to undertake prestigious joint or sabbatical posts with **external partners**. Examples include **Piddock** seconded to the Global Antibiotic Research & Development Partnership (GARDP) as the Head of Scientific Affairs and **Lord** as Specialist Advisor to The House of Lords Committee inquiry into Ageing. **Barone** has taken a two year sabbatical to work as the Vice President of Experimental Medicine in a life science company. **McNally** was seconded to UK Biocentre to lead establishment and operation of the Lighthouse SARS-CoV-2 diagnostic facility in Milton Keynes and now leads an NHS COVID-19 turnkey lab in Birmingham, the first of its kind integrated with a University campus.

- We embrace the importance of working with **policy makers and politicians** at local and national levels. Staff have participated in the Royal Society MP pairing scheme that saw staff buddy up with local MPs within parliament followed by local visits and discussions with ECRs (e.g. **Parish & Stuart MP**) and had representation at ‘Speaker’s open days’ to promote research interest. Our staff are actively involved in current debates regarding future arrangements for regulation and clinical trials.

#### 4.2. College/institutional support to enable collaborations nationally/internationally, with indicators of success

- The ethos of collaborative research is encouraged across UoA1 at all levels. Recent survey data show **>94% of UoA1 senior academics and 70% of junior academics are active in national and international collaborative research programmes**. Collaboration supports personal training, shares expertise and technologies and supports translation of research programmes. We are a leading centre for sponsoring and conducting clinical trials in over 20 countries internationally including Europe, Australasia, North America and Africa.
- These ambitions are facilitated by UoA1 investment in international leading technology platforms such as the Henry Wellcome NMR centre and COMPARE. UoA1 uses Wellcome Institutional Strategic Support Fund (ISSF) and College Research Funds to support international travel and training.
- This strategy has resulted in a **60% increase in the number of publications published jointly with international colleagues**, from 392 in 2014 to 627 in 2020 (Fig 4.2).



**Figure 4.2 UoA1 publications published jointly with international colleagues**

- Our Institute for Global Innovation (IGI) (REF5a 2.3.3) is a new UoB investment addressing key global challenges and current themes with UoA1 including Gender Inequality, Ageing and Antimicrobial Resistance. IGI incorporates our **Institute for Advanced Studies** (REF5a; 2.3.1) which provides funding for interdisciplinary workshops and visiting international Fellowships.

#### The UoB Campus in Dubai and international engagement

- Birmingham is the first Russell Group University to establish a campus in the rapidly developing international education hub of Dubai. The full campus will open officially in 2021, embedded with cutting-edge technology for education and research expertise, and designed to promote environmental sustainability. UoA1 research ambitions will focus initially on strategic partnership between the Dubai Health Authority (DHA) and the UoB Global Surgery Unit to create the first Surgical Research Hub in the Middle East, bringing UAE into a global surgical network of 20,000+ clinicians across over 110 countries.





**Figure 4.3 UoB Dubai campus (artist impression) and the UoB Guangzhou office**

- We have also established a dedicated UoA1 investment in two BRIDGE exchange fellows, working in Brain Trauma and Genomics, with the University of Illinois Urbana-Champaign, the former leading to a spin out company (1.3.2).
- UoB has research partnerships in China, managed through its China Institute and administrative centre in Guangzhou (Fig 4.3). Biomedical collaborations include health cohort studies involving the middle-aged and newborn (n=50k) and a drug discovery partnership with the Guangzhou Institutes of Biomedicine and Health, which has identified novel lead compounds. Biomedical engineering is linked with Southeast University in Nanjing and the Institute of Biomedical Devices in Suzhou, including AI approaches for image analysis of brain cancer. A new institute has been launched in Nanjing (the Nanjing Brain and Life Science Research Institute), directed by Birmingham academics and with close links to major hospitals in Nanjing.
- We have capitalised on the significant South Asian population in Birmingham by developing strong links with India since 2014, primarily with the UoB Global Surgery Unit where the India hub is a leading partner, and an MoU with the International Centre for Genetic Engineering and Biology (ICGEB) focussing on compound screening for identifying autophagy modulators and including student and staff exchange. Exciting future plans include (i) partnership with the National Health Agency for India (responsible for insurance provision of 500+ million citizens) in data science, clinical quality standards and fraud prevention and (ii) development of a Centre on Connected Surgical Ecosystems for Non-Communicable diseases (NCDs).
- In light of Brexit, the UoB has invested in the legal framework to enable continuity of sponsorship of our extensive clinical trials activity in European member states. To further extend our European footprint, we have developed strategic alliances with Trinity College Dublin, which will focus over the next 5 years on Clinical Trials research, as well as the University of Amsterdam with an initial focus on cardiovascular disease and microbiology.
- In 2019 UoB co-founded EuniWell, *the European University for Well-being*, a trans-European alliance uniting 7 universities and recently selected as a 'European University of the Future' in the 2nd round of the European Universities initiative (2020). This provides UoA1 staff access to €7M of Erasmus+ and Horizon 2020 funding and Birmingham, Florence and Leiden have now established a network around anti-viral therapy with a proposal on musculoskeletal health also well advanced.
- UoB has a dedicated Brussels Office which provides a central focal point for researchers to engage within Europe, a facility that has underpinned many successful Horizon awards. It has also expanded support for international activity with the provision of a

specialist team to support researchers in delivering both European and International funded projects, including NIH.

#### 4.3. Examples of relationships with 'research users, beneficiaries or audiences' for impact and enrichment of UoA1 research environment

BHP creates our overarching framework for collaboration with the NHS, providing a trusted interface for new and ongoing interactions with our two major local hospitals. Beyond this, we have a range of strong NHS relationships across the region and UK which enable us to deliver large-scale trials and clinical studies. In addition:

- UoB manages one of the largest Clinical Immunology Services in the UK, providing analysis of 64,000 samples annually and providing expert advice for complex immunology and haematology patients. This contributes substantially to the care of 4000 patients each year, facilitated the development of a wide range of academic programmes and initiated the development of Binding Site Ltd, one of the largest Pharma SME in the UK.
- With industry, we have developed a significant portfolio of 'trusted advisors' who are connected to our devolved funding schemes such as MRC Confidence in Concept and our Wellcome Translational Partnership. These are drawn from across a wide range of industry sectors, and provide both bespoke advice to individual academics as well as joining our "Project Translational Groups" which perform a permanent advisory role for our funded innovation/commercialisation projects. Major companies such as Google and Roche are partners in our Health Data Research Hubs (INSIGHT and PIONEER), while emerging partnerships such as that with Bruntwood SciTech (the UK's foremost operator of science parks) are enabling us to develop the roadmap and investment portfolio required to realise our vision the Birmingham Health Innovation Campus (Fig. 3.2).

#### 4.4. Wider contribution to economy and society, beyond impact cases studies

UoA1 has myriad examples in this area and selected exemplars include:

- **Drayson** has been a global pioneer in the use of antibiotic prophylaxis in patients undergoing chemotherapy and the recent TEAMM trial showed that 12 weeks of levofloxacin reduced febrile episodes or deaths by 34% in patients with a recent diagnosis of myeloma.
- **Craddock** led development of the Centre for Clinical Haematology at the QEH, which co-locates a state-of the-art clinical facility with a satellite of the University of Birmingham CRCTU Trials Unit. Major extension in 2018 has developed an internationally competitive portfolio of haemato-oncology trials and accessed more than £200M of novel drugs for patients across the UK through its Trial Acceleration Programme (TAP). This further strengthened **Buckley** to develop an arthritis A-TAP with £7.4M from the Kennedy Trust Foundation.
- **Bryan** has developed the introduction of narrow band imaging (NBI) for cystoscopy where beneficiaries include industry suppliers Olympus and Storz Spies who have introduced this as standard technology. Patients are thus benefitting from earlier diagnosis, more complete removal of lesions and reduced risk of reoccurrence.

#### 4.5. Organisational approach to patient/public engagement and involvement with research, particularly where relating to diverse communities

Since 2015 we have developed a team of dedicated patient involvement specialists who support numerous major infrastructure projects including the NIHR SRMRC, PIONEER HDR Hub and the NIHR ARC and Global Surgery Unit. This team work with NHS partners to develop and implement a clear strategy which embeds the patient voice within UoA1 research activity. To ensure engagement with diverse communities, we have taken specific steps to identify underrepresented groups and set up effective initiatives to work with these. For example, in the frail elderly we established the '1000 Elders' cohort (**Lord**), supporting translational studies and holding an annual celebration event for participants in the AgeWell conference. Additional initiatives include:

- PILAR (the Patient and Public Involvement and Lay Accountability in Research and Innovation Leaders Forum),
- Involvement and Engagement in Cancer Research at Birmingham (ICRB) group. Through our NIHR CRF we have increased PPI/E by appointing 14 research ambassadors who specifically represent communities in research that are traditionally difficult to access. This has increased BAME participation in our research portfolio, making our research outputs more representative of our population.

#### 4.6 . Category C staff

As befits our integrated campus, category C staff are at the heart of UoA1 research and contribute substantially to research environment and impact enablement. CMDS has >1000 honorary staff and exemplars include:

- **Denniston** in Health Data, Deputy Lead for HDRUK and global expert on ethics in AI;
- **Foster** and **Blanch** in Defence Medicine;
- **Moimen** in the Centre for Conflict Wound Research;
- **Cook** and **Pratt** in Oncology, leading UK myeloma trials;
- **Steeds** with international profile in cardiac MRI imaging;
- **Chu, Clark, Latthe** and **Meher** as integral partners in the WHO maternal health unit;
- **Mirza, Tripathi, Moissen** in Liver disease and transplantation.

#### 4.7 Encouraging and developing best practice in undertaking research that is reproducible

UoA1 has strong programmes to ensure reproducible science and mandates complete reporting of scientific design, conduct, data and analytical approaches.

- *Methods reproducibility*, such that experimental and computational procedures use data and tools to obtain the same results, is promoted by education and presentations that convey importance of the study protocol, experimental approaches, software codes and analytical techniques. The challenge arising from biological 'batch effects' is minimised at each step and automated analyses are encouraged. In clinical setting we encourage consistency in selection of study criteria and internationally-accepted criteria for assessment.
- *Results reproducibility* or 'replication' is ensured by seminars and education on the importance of experimental design, adequate powering of studies and standardised experimental protocols and technologies. Our data are archived for 10+ years and we will experiment with the development of 'living' figures. We encourage reporting of 'negative' studies.
- *Inferential reproducibility*, referring to consistent knowledge claims from data, is underappreciated and here we utilize our expertise in trial design and Bayesian statistics to educate on optimising interpretation and analysis of datasets. Caution is emphasized in

not overstating data findings. We strongly encourage engagement in peer-review and open access review statements.

#### 4.8. Contribution to sustainability and profile of academic medicine

Regarding **sustainability** of medical training, we have undertaken a major review of Undergraduate training and increased Medical Student intake to 400 annually. The importance of research culture is embedded from the first week of tuition (2.3.5) and **Middleton** and **Raza** have secured funding for 25 MD-PhD awards.

Our academics support research development within the NHS. **Raza** was Director of Research and Development at Sandwell & West Birmingham NHS Trust (2014-2018), doubling research activity by leading a bespoke Clinical Research Facility (2019). **Morton** was Director of the West Midlands Genome Medical Centre (WM GMC), overseeing the largest contribution of cancer samples from any region. **Jones** is lead investigator on 4 clinical studies at the Royal Orthopaedic Hospital NHS trust.

UoA1's early response to environmental sustainability issues was to set up an academic Environment and Sustainability Committee in 2011. Chaired by a senior academic (**McCabe**), this comprises academics, estates staff, PGR and undergraduates, with a remit to promote sustainable working. Major initiatives include (1) targeting staff behaviour, such as ensuring that fume hoods are only operated when necessary, (2) pioneering approaches to decrease laboratory use of disposable plastics and (3) increasing recycling, centralised printing and usage of Green Impact Labs Scheme. Support for the UoB spin-out UniGreenScheme which recycles obsolete equipment and donates funds back to UoB, has allowed the committee to invest >£20,000 to enhance biodiversity and tree planting. Looking forward, we will feed into UoB Sustainability Steering Committee, which adheres to the United Nations Sustainable Development Goals and promotes sustainable societies.

Our **profile** is demonstrated through a variety of exemplars. UoA1 academics support UoB Communication and Marketing services to communicate their research to the public, including Piddock who has played a prominent position in communicating the importance of Anti-Microbial Resistance and the work of Coomarasamy in relation to the utility of progesterone in recurrent fetal loss, where the PRISM study has initiated an increase in use of progesterone by UK mothers with threatened miscarriage from 12% to 74%.

#### 4.9. Institutional approach to supporting interdisciplinary research, with key examples of success

Interdisciplinary engagement is a core principle underlying research culture within UoA1, with many examples developed since 2014 and explained fully in 1.4.5. In addition:

- The Drug Discovery initiative (1.4.5) has curated a library of novel drug-like molecules synthesised within the University, developing topical delivery system for glaucoma.
- Healthcare technologies, led by **Grover**, operates between Chemical Engineering and the Healthcare Technologies Institute in the ITM and has outreach to Engineering, Chemistry, Metallurgy and Materials and Mathematics. The group secured £7M from EDRF and UoB to start the Medical Devices Testing and Evaluation Centre (MD-TEC) programme. This refurbished 1200 m<sup>2</sup> within the ITM creating high-quality lab space to conduct research in collaboration with local companies. Recent funding successes total £10M including £3M

from the ScarFree Foundation to establish the only UK Centre for Conflict Wound Research. Future plans will increase the ITM footprint and nurture companies within Birmingham Health Innovation Campus.

- Major innovations have developed within computational biology and health data, enabled by BHP. The University joined the Alan Turing Institute in 2018, with particular emphasis on programmes of work on Computational Life Sciences and Complex Image Data. Seven UoB Turing Fellows hold project funding with connections to the life sciences.
- Links with Physics and Chemistry are pursued with shared research programmes, ‘speed-dating’ events and student exchanges that seed novel collaborations. Examples of engagement include ‘big-data’ analysis of clinical informatic datasets and novel approaches to interrogate biological datasets. Interactions with Chemistry include application of novel polymer technologies for novel technologies in drug release.
- UoA1, through the Birmingham Fellow and Interdisciplinary Fellow schemes, has been able to appoint a number of interdisciplinary fellows who actively work at the interface of the medical and physical sciences, including [Metcalf](#) for work on wound healing.

#### 4.10. Examples of how UoA1 responds to emerging national and international priorities and initiatives

UoA1 has shown itself to be agile and comprehensive in its **response to major challenges** that have arisen since 2014. COVID research is shown below and additional initiatives have included:

- HDRUK PIONEER data platform in response to the crisis in acute medicine admissions in secondary care (1.3.2).
- [BactiVac](#) as a contribution to overcoming anti-microbial resistance, a unique academic/industrial network that accelerates development and uptake of vaccines against bacterial infections in low and middle-income countries (LMICs).
- Leadership in mentoring and personal support (2.2.5) in light of national concerns over mental health and research culture.
- The Lancet Commission on *Global Surgery* identified a global deficit of 143 million surgical operations annually, the majority of these within LMIC. Development of our [UoB Global Surgery Unit](#) is addressing this challenge and, with a worldwide shortage of 2.2 million surgeons and anaesthetists, we are partnering with LMIC to undertake innovative training and quality assurance initiatives. The Unit is a consortium between Birmingham, Edinburgh & Warwick together with our international partners at hubs and centres around the world, including Ghana, Rwanda, South Africa, Mexico, India and Nigeria.
- Multimorbidity has been identified as a major health challenge by the CMO Professor Whitty and through BHP we set up a Multi-morbidity Working Group within ABPI to address issues such as lack of representation of older adults in clinical trials.

##### 4.10.1 UoA1 response to the SARS-CoV-2 pandemic

As would be expected, UoA1 staff made a very significant contribution in the international response to the Covid-19 pandemic, contributing influential policy advice. UoA1 infrastructure was critical in this regard, keeping laboratories open throughout 20/21 and providing financial support for posts and consumables. Research is described under four themes:

#### 1. Testing

**McNally** was seconded as Infectious Disease lead for the Milton Keynes Lighthouse Laboratory for PCR testing. He played an integral role in initiating the programme and delivering capability for

>2 million tests by 31 July 2020. He now works with **Richter** running the Turnkey laboratory at UoB, processing >100k tests per month. The laboratory is linked into the COVID genome sequencing facility, part of the COG UK consortium of which Birmingham were founding members. Through the Birmingham CLIMB-COVID platform the Turnkey laboratory can provide real-time data integration & analysis for UK & global genomics.

**Beggs** utilised UoA1 research laboratories to initiate a rapid programme of viral antigen testing at the height of the pandemic. This has now gained ISO/UKAS and Government accreditation. He also led a pilot study to assess effectiveness of the Oxford Nanopore 'LamPORE test' and designed the LamPORE Respiratory Panel, a multiple-pathogen test to allow healthcare professionals to distinguish respiratory infections.

## 2. Clinical management

**Sapey** is chief investigator for DECOVID, with the Turing Institute, UVL and UCLH, a research database and analytical environment for COVID analysis (UKRI £1.25M). She is co-lead for UKRI-funded projects in risk prediction models and COPE-COVID study of health impact of COVID on NHS staff.

**Kearns, Gates and Sharpe** initiated CATALYST (£450K UKRI), an early phase multi-arm platform trial rapidly evaluating new drugs for severe COVID19 for entry into RECOVERY.

**Newsome** utilised ATTC and BRC funding to initiate a study of mesenchymal stem cells from patients with COVID 19-related pneumonitis.

**Campbell-Hill** developed the AerosolShield (Disposable Resuscitation, Intubation and Nebulisation Kit), a compact device that was designed to cover the patient's head, neck and shoulder area while treatments for COVID-19 are administered and rolled out internationally.

**Sundar** evaluated viral swabs to understand transmission risk to operating teams and laparoscopy.

**Middleton and Lee** launched the UK Coronavirus Cancer Monitoring Project, a national project that pioneered the use of clinician-led reporting to track cancer patients and inform treatment pathways. They established that in-hospital mortality rate is not significantly affected by chemotherapy and this has been used globally to enable re-introduction of cancer services.

**Lord** was author on the Academy of Medical Sciences report on the Immunology of COVID-19, and presented this to SAGE.

Through the Royal Academy of Engineering's Pandemic Preparedness call, **De Cogan** designed anti-viral air filters to tackle the spread of SARS-CoV-2 on public transport to protect passengers.

## 3. Immunology

**Richter, Cunningham and Wraith** worked with Binding Site PLC to develop a diagnostic ELISA antibody test with >98% sensitivity and specificity. This was used to define SARS-CoV-2 as the cause of the Kawasaki-like syndrome (PIMS-TS) in children (with **Schofield**).

**Moss** initiated and leads the UK Coronavirus Immunology Consortium (£6.5 million, UKRI). He also directs cellular analysis of the VIVALDI national care home study and reports to Government Chief Science Advisor as Lead for the National Core Studies in Immunity (£7M 20/21).

#### 4. International

**Morton, Bhangu and Nepogodiev**, through the NIHR Global Health Research Unit on Global Surgery, launched the CovidSurg Collaborative, capturing real-world data and sharing international experience throughout the pandemic. Data showed that patients undergoing surgery after contracting SARS-CoV-2 were at greatly increased risk of postoperative death and led to 28+ million elective surgeries worldwide to be cancelled in 2020. This resulted in a priority paper in the *Lancet*, which achieved the highest ever Altmetric score of any surgical manuscript, informing World Health Organization guidelines.

**Thangaratinam**, through the WHO Collaborating Centre for Women's Health, evaluated the maternal and offspring outcomes, published in a living systematic review in BMJ.

##### 4.11 Markers of Esteem

- UoA1 researchers **undertake national and international leadership roles** at many levels, reflecting career stage. Most notably: **Adams**, Chair of Diabetes UK Research Committee and BHF Programme grants committee; **Moss**, Chair of MRC Infection & Immunity Board (14-18); **Arlt**, Chair of AMS Starter Grant Panel (16-20); **Terry**, Chair of UKRI Centre for Doctoral Training in AI (2018), **McCabe**, Chair, Science Committee, Society for Endocrinology UK (2014-2019); **Craddock**, Chair UK Stem Cell Strategic Oversight Committee (2010+).
- Our staff contribute to many **national and international societies, committees and agencies** including: **Newsome**, Secretary-General European Association for the Study of the Liver (EASL); **Craddock**, President British Society of Haematology (16-18); **Kearns**, President European Society of Paediatric Oncology; **Sundar**, President British Gynaecological Cancer Society.
- Our researchers also drive **agenda and policy change** by writing national and international guidelines through peer review and standards associations including: **Boelaert**, Chair, NICE Guideline 'Thyroid Disease-Assessment and Management' (2019); **Arlt**, Chair EJE COVID-19 International Consensus Guideline 'Management of Adrenal Insufficiency (2020); **Thangaratinam**, Chair EJE COVID-19 International Consensus Guideline "Management of Gestational Diabetes"; **Parry**, Chronic Leukaemia UK guidelines; **Sundar**, Ovarian Cancer British Gynaecological Cancer Society (2018); **Buckley & Raza**, Rheumatoid European League Against Rheumatism (2017); **Monteiro**, member of Clinical Medicine Animal Welfare and Ethical Review Bodies (2014-2017)
- Our strong **business engagement strategy** involves numerous staff who provide expert advice and consultancy to industry, influencing their R&D programmes, including through representation on Advisory Boards. Exemplars include Roche (**Brill**), Merck & Co/GSK/AZ (**Mehanna**), Sanofi (**Lord**) and Bayer (**Kotecha**).
- Our research excellence is also evident through senior editorial positions. **Editors-in-Chief** include: **Buckley**, Chief Editor of 'Arthritis Research and Therapy'; **Gupta**, Chief Editor of "European Journal of Obstetrics and Gynecology and Reproductive Biology", **Watson and Harrison**, Chief Editors of "Platelets"; **McNally**, Senior Editor for Microbial Genomics; **Karavitaki**, Senior Associate Editor, Hormones, 2016+; **Arlt**, Editor-in-Chief, European Journal of Endocrinology, 2019+.

- Our researchers continue to be recognised at the **highest levels internationally** as reflected in prestigious awards and Fellows of Learned Societies, most notably **Turner** and **Tomlinson** as FRS (2015, 2019), **Arlt**, European Society of Endocrinology Trust Medal (2016); **Shetty**, Lancet Young Investigator prize (2017); **Yap**, Edgar Gentilli Prize from Royal College of Obstetricians and Gynaecologists (2017); **G Taylor**, NCRI Prize for Translational Research (2015); **Croft** and **McGettrick** Linacre Medal and Garrod ECR Prizes British Society for Rheumatology; **Buckley** Heberden Oration; **Arlt**, Berthold Medal at German Society of Endocrinology and first female European to receive Outstanding Clinical Investigator Award from the USA Endocrine Society.
- **Invited keynote lectures** at (inter)national conferences, society meetings and other Universities have been made by virtually all UoA1 staff. Highlights include: **Parish**, Plenary session at American Society for Virology Annual Conference (2020); **Cox**, keynote at Microbiology Society Early Career Scientists (2020); **Bonifer**, Plenary at European Haematology Association (2019); **McNally**, Plenary at ASM Microbe Annual Meeting, (2019); **Mehanna**, Presidential Plenary at European Society of Medical Oncology; **Gupta**, Keynote Lecture at the EBCOG conference; **Drury**, Hunterian Professorship at Royal College of Surgeons.