Institution: King's College London
Unit of Assessment: 5
1. Unit context and structure, research and impact strategy

Research structure, vision and scope:

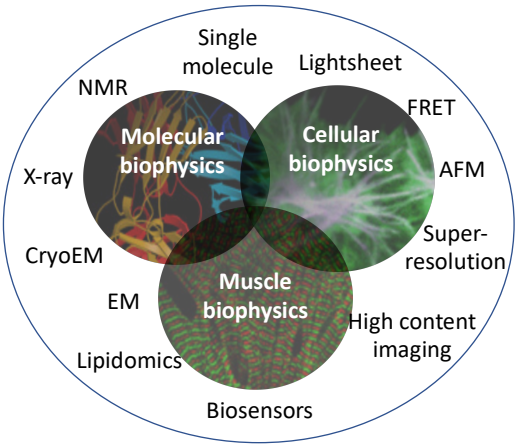
Our return in UoA5 comprises 34 current research teams, totalling 120 researchers, populating The Randall Centre for Cell and Molecular Biophysics (**Randall**) in the newly established School of Basic and Medical Biomedical Sciences within the Faculty of Life Sciences and Medicine (FoLSM) as well as two affiliated molecular biology teams in Forensics. The **Randall** brings together cell and developmental biologists, structural and molecular biologists, biophysicists and chemists working collaboratively to elucidate the mechanisms of cell and tissue function using innovative imaging and biophysical approaches. We adopt an integrated multidisciplinary approach to biomedical research at molecular, cellular and whole animal levels, and with an active interface with associated clinical and Industry partners. Our research ethos exemplifies the King's Strategic Vision 2029 ambition, enabling the highest quality discovery-driven research, interdisciplinary working and external partnerships to address key biomedical challenges. We showcase our research to, and work with, a global audience of academics, commerce, social enterprise and government, and recruit, develop and retain the best early career and established researchers.

Our 2021 return in UoA5 is smaller than in REF2014 (32.3 vs. 73.8FTE) and this reflects the 2017 change in Faculty structure at King's resulting in the previously associated Neurobiology teams joining the Faculty of Psychiatry, Psychology and Neuroscience (UoA4). The overall health sciences strategy at King's is to develop a translational pathway for our basic biomedical sciences by linking into our extensive clinical base. The move of basic neurobiology into UoA4 reflects this strategic vision. Collaborative links with UoA5 and neurobiology continued throughout the assessment period (>25 co-authored publications and >£2M in shared grants) and close links with cancer and other clinical disciplines provide the translational pipeline for the basic sciences in UoA5. It is also notable that there are a number of additional basic biomedical researcher teams embedded within other FoLSM departments (Immunology, Cancer, Cardiovascular), who are returned in UoA1 along with their associated clinical colleagues. The restructuring also resulted in the Randall joining 4 other departments (Genetics, Dermatology, Stem Cells and Human Physiology) to form the School of Basic and Medical Biosciences. This has enabled new collaborations across departments resulting in shared grants and PhD students, as well as enabling implementation of cross-School equipment sharing and training, including the recent Wellcome trust award for a laser Micro-dissection/tweezers system (PI **Gautel**; £0.4M) and BBSRC ALERT19 to build a bespoke lightsheet microscope (PI **Cox**; £0.35M) facilitating new research activity across a number of departments.

Our multi-disciplinary strategy and outlook mean much of the research in the Randall crosses UoA boundaries, thus although its centre of mass lies in UoA5, >20% of the embedded staff have joint appointments with other Schools and Faculties (Chemistry, Physics, Maths, Cardiovascular Sciences, Immunology and Cancer/Pharmaceutical Sciences) or the Crick. This design encourages and facilitates a seamless combination of molecular, cellular, tissue or whole animal approaches in many labs. The interface between basic biomedical science and experimental medicine has been further developed through our Academic Health Sciences Centre, King's Health Partners, with its Clinical Academic Groups that provide a set of translational and reverse-translational pipelines linking basic science and clinical medicine and that Randall teams actively participate in (see "Research Sections and Themes" and "Research Impact" below). New links at that interface have also been stimulated by our NIHR-funded Comprehensive Biomedical Research Centres (£64m; 2016-22) and associated translational PhD studentships, of which >40% of UoA5 returnees have been recipients of, further demonstrating the synergistic interface between fundamental molecular research and outstanding clinical questions. The interface with physical sciences, engineering and maths is equally well developed, through different mechanisms. The Physics/Biology interface has been a research focus for King's since the 1950's, following Franklin and Wilkins contribution to the discovery of the structure of DNA, and this biophysics tradition

continues in the Randall. A major growth area has been in computational, structural and image analysis, with the development of novel optical microscopy platforms and tools for super-resolution, functional imaging, protein structure interrogation and cryo-electron microscopy. Links to the newly established (2014) Chemistry department have increased through the research interests at the chemical biology interface. Links to maths, computer science and informatics have been stimulated by joint research grants and studentships (see Section 3). We also have strong links with the Francis Crick Institute (Crick) through secondments, sabbaticals and shared students. The Randall is housed in ~3000m^2 of research space on the 2nd and 3rd floors of New Hunt's House on the Guys Campus, shared with some collaborating teams from School of Cancer and Pharmaceutical Sciences. This space is designed specifically for our research needs and includes specialised facilities and infrastructure to support the core research themes described below.

Research Structure and Sections:
Since 2014 we have made strategic investments in new tenured staff and in our facilities to enhance our scientific reach and enable us to position our research at the cutting edge of important new areas in biophysics and cell biology. In 2018 our Research Sections were consolidated into three overarching themes that reflect the vision and scope of research within the Randall. There is significant collaboration between Sections, as evidenced by >100 co-authored outputs and >40 shared grants from individuals within these groups.



The Randall is Directed by **Fraternali** and comprises 3 research sections; Cellular Biophysics (led by **Eggert**), Muscle Biophysics (led by **Ehler**) and Molecular Biophysics (led by **Sutton**). The Randall Steering committee (comprised of the Director and section heads) meet every 2 months to discuss funding, recruitment and staff support strategies. This information is then fed back for discussion at the Randall research faculty meetings (every other month); the Randall PhD and Research staff reps also join these meetings to ensure open discussion, transparency and clarity on decision-making across our research base. **Fraternali** also sits on the School Executive committee that meets monthly (that is chaired by **Gautel,** who is Head of School), and this provides an opportunity to discuss emerging issues, input into School-wide plans and policy and feedback to Randall staff on Faculty/School-led initiatives.

Molecular Biophysics.
Understanding protein structure is critical to defining function and invaluable in designing therapeutic agents to alter protein function. The Molecular Biophysics Section, led by **Sutton,** has a strong focus on Structural Biology and the determination of protein structures by X-ray crystallography, cryoEM and NMR. These are supported by other biophysical techniques, computational biology and bioinformatics. Current research interests span antibody-receptor interactions in allergy (**Beavil, McDonnell, Sutton, Gould**); antibiotic resistance (**Bergeron, Sanderson, Fraternali**); enzyme structure and mechanism (**Conte, Steiner**); protein-RNA and protein-DNA interactions (**Conte, Sanderson**); anti-viral drug design (**Fraternali, Sanderson**); cardiovascular structural biology (**Conte, De Nicola, Gautel, Pfuhl** (UoA1)); rational drug design (**Conte, De Nicola, Fraternali**); muscle protein structure (**Pfuhl, Steiner**); single molecule force spectroscopy (**Garcia-Manyes** (UoA9)); cytoplasmic transport proteins (**Atherton, Steiner**); structural bioinformatics and molecular dynamics simulations (**Fraternali**). Extensive interactions and collaborations exist between teams within this Section, as well as strong links with other departments including Immunology (**Fraternali, Sutton, McDonnell, Beavil, Gould**), Cancer (**Conte, Fraternali**), and Cardiovascular (**Pfuhl, Fraternali, Steiner**), combining techniques in structural biology, molecular genetics and cell biology. The work of the section is supported by recent successes in infrastructure funding (£3.6M to establish the new NMR Facility, see Section 3), and the Centre for Biomolecular Spectroscopy (£260K from BBSRC 19ALERT for an isothermal titration calorimeter). **Gautel** (Muscle Biophysics) and **Steiner** are co-Is on the £3M Wellcome Trust grant that enabled the establishment on the London Consortium of cryo-Electron Microscopy

(LonCEM) equipped with state-of-the-art transmission electron microscope and detector. Computational work relies on KCL infrastructure supercomputing facilities ('Rosalind').

Major achievements in the review period:
A major future focus for this section since 2014 was to extend emerging biophysical techniques to the development of new therapeutics through increased partnering with clinicians and Industry. We have achieved this goal in a number of ways: through development of new methods to characterise enzyme structure, function and inhibition (**Conte, De Nicola, Fraternali, Steiner**); by performing atomic-level structural studies to reveal new understanding of allostery and allosteric inhibition (**Beavil, Conte, Fraternali, McDonnell, Sutton**);resolving structures of topoisomerase target enzymes in complex with clinically important anti-microbial and anti-cancer drugs (**Sanderson**). We have also investigated macromolecular events and processes to acquire a deeper understanding of the molecular basis of health and disease states, developed new ways of monitoring and manipulating them and to help develop new drugs that have the potential to be translated into the clinic. In this respect, examples of partnerships with industry include the work on IgE-receptor inhibition in a collaboration of **Sutton, McDonnell, Beavil** with the pharmaceutical company UCB Pharma, that has led to a Phase I clinical trial of a small-molecule inhibitor, and development of an antibody-based inhibitor, to treat allergic disease including asthma. We have additionally developed prediction tools to identify regions of protein instability and protein-protein interaction networks in cancer biology (**Fraternali**). At the fundamental level, we have made major discoveries in the protein domain interactions involved in muscle assembly and dynamics (**Pfuhl, Steiner**), mechanisms of cargo recognition by molecular motors (**Steiner**) and novel mechanisms of protein-RNA interactions regulating gene expression (**Conte**) as well as performing analyses of B-cell development and antibody class switching (**Fraternali, Gould**).

Future Plans:
- With two new appointments in cryoEM (**Bergeron, Atherton**) we will establish a complete pipeline for single-particle structure determination and tomographic analysis, bringing these methodologies to bear on several projects: host-pathogen interactions and bacterial cell organisation (**Bergeron**, with **Malim** and others {UoA1]); kinesin regulator proteins and cytoskeletal organisation in neurons and glia (**Atherton**); muscle protein and microtubule-mediated transport processes (**Steiner, Pfuhl, Gautel**); antibody structure (IgE, IgD and IgM), antibody/antigen/receptor and B-cell receptor complexes (**Sutton, McDonnell, Beavil, Gould,** with **Spillane, Karagiannis**); higher-order DNA gated topoisomerase complexes with anti-microbial and anti-cancer drugs (**Sanderson**); protein/RNA assemblies and unconventional RNA-binding proteins in particular (**Conte**).
- Defining targets for therapeutic intervention is a focus for much of the work of this Section, for example allergic disease (**Sutton, McDonnell, Beavil, Gould**), viral (**Sanderson, Fraternali**) and bacterial infection (**Bergeron, Sanderson**), cardiac disease (**Steiner, Pfuhl, Gautel, Atherton, Fraternali**) and cancer (**Conte, Atherton, Sanderson, Fraternali**). We shall also develop a novel, highly transferable low-cost pipeline using in-crystal fragment screening to develop protein-protein inhibitors (**De Nicola, Fraternali**).
- We will develop and apply novel nanomechanical techniques to explore the conformational dynamics under force of proteins involved in cellular mechano-sensing and mechano-transduction, spanning the focal adhesion, cytoskeleton and nuclear levels (**Garcia-Manyes (UoA9), Gautel**). This will be further enabled by recent award of a Leverhulme Trust PhD programme to Garcia-Manyes (UoA9), entitled "Understanding the Mechanics of Life".
- Systems Immunology and Biology will be a focus (**Fraternali**), studying antibody class-switch recombination (with **Gould**), allosteric communication and inhibition (with **McDonnell, Conte**), and the RNA interactome (with **Conte**). We will expand our single-cell transcriptomics analyses to disease trajectories in COVID-19 patients (**Fraternali**). Development of tools to analyse healthy and disease-related variants (Cardiac and Cancer) will be directed to build a multi-omics data predictor of protein stability and inferred pathogenicity (with **Gautel, Karagiannis, Capon, McGrath, Parsons**).
- The Centre for Biomolecular Spectroscopy (led by **Conte**) will remain the College-wide hub for NMR and other biophysical techniques (refer above to upgrade of facilities), as well as

for NMR-based proteomics analyses. We shall continue to forge new links with London partners including the LCN, The Crick and LonCEM, to further build our collaborative base and enable new technologies to be accessed for our research.

Cellular biophysics

Correct division and coordinated migration and adhesion of cells are essential for the establishment and maintenance of multi-cellular organisms, developmental processes, wound healing and immune responses, and also contribute to the progression of pathologies including chronic inflammatory diseases and cancer. The Cellular Biophysics Section, led by **Eggert**, share a common interest in studying the role of the cytoskeleton in cell division, adhesion, migration and intracellular traffic. Teams in this section analyse the signalling networks controlling the cytoskeleton, ranging from mechano-chemical stimuli to protein-protein interactions, to the roles of membranes and lipids. We use cultured cells, model organisms and advanced microscopy coupled with chemical, biochemical, biophysical and molecular biology tools and mathematical modelling to study the dynamic movement and activation of proteins in cells. Advanced mass spectrometry is also employed to identify key protein and lipid players in these processes. Many interactions and collaborations exist between teams within this Section, as well as strong links and joint appointments with the School of Cancer and Pharmaceutical Sciences (**Rosenblatt, Ameer-Beg**), Physics (**Spillane, Owen**) and Chemistry (**Eggert**) departments, and with the BHF Centre of Excellence (**Parsons**), Cancer Research UK Comprehensive Cancer Imaging Centre (**Rosenblatt**) and Crick (**Oliferenko**).

Major achievements in the REF period:

An overarching ambition for this section from REF14 was to develop and apply new advanced live imaging approaches to understand architectural changes in response to external cues. We have achieved this goal at both organismal and multicellular levels, making important discoveries of how the actin cytoskeleton and the extracellular environment work together to guide cell movement during development (**Stramer**), defining how the crosstalk between the cytoskeleton and factors influence the tumour microenvironment (**Sanz-Moreno,** until 2019) as well as seminal findings on the role of mechanics in stretch-activated channel-mediated epithelial homeostasis (**Rosenblatt**). At the cellular level, ground-breaking work showed that lipids are key interactors of the cytoskeleton, with essential roles in the division of different yeast species (**Oliferenko**) and human cells (**Eggert**). Many teams used innovative imaging approaches to discover and characterise the roles of proteins involved in cellular processes mediated by the cytoskeleton (**Ridley, Jones, Krause, Oliferenko, Eggert, Parsons, Dodding** until 2018**, Rosenblatt**). Molecular mechanisms were investigated, including those governing the spatial organisation and signalling of membrane receptors that trigger cytoskeletal assembly in the context of inflammation and cancer (**Parsons**). New techniques were developed for super-resolution and biomechanical imaging (**Cox, Owen, Parsons, Spillane**), fluorescence lifetime imaging (**Ameer-Beg, Suhling** (UoA9)), single molecule imaging (**Cox, Ameer-Beg, Padilla-Parra** (UoA1)) and multiphoton-based intravital imaging (**Ameer-Beg, Ng** (UoA1)) improved by adaptive optics and applied to image pathophysiological processes in live animals in vivo. We also recently established novel high-content imaging platforms for cancer cells and tissues for drug/siRNA screens and prognostic disease marker discovery (**Ameer-Beg**).

Future plans:

- A number of groups will focus on the mechano-biological stimulation and regulation of the cytoskeleton (**Parsons, Cox, Oliferenko, Stramer**); **Eggert, Rosenblatt** and **Spillane** are part of a very recently awarded BBSRC sLola grant to understand how mechanical forces regulate cellular monolayers. Within this theme, we will develop new probes to study mechanically-driven changes to proteins in live cells and whole organisms and then apply these to understand how cells sense mechanical changes in the environment and how this leads to fibrotic diseases (**Parsons, Stramer**). We will also use these probes to measure and image forces cross immune cell membranes and define how these contribute to B-cell activation (**Spillane**). This will be further enabled by recent award of a Leverhulme Trust PhD programme ("Understanding the Mechanics of Life") to **Garcia-Manyes** (UoA9).

- Protein-lipid interactions play a key part in defining cell division and cytoskeletal dynamics, and we will develop novel tools to identify and image lipids in live cells, including a new class on molecular 'rulers to assess altered lipid packing within live cell membranes (**Eggert**).
- We will perform advanced high-content imaging of cancer cells (**Parsons**) and tissues (**Ameer-Beg**) for prognostic disease marker discovery. Multiscale (whole body and nanoscale) imaging of pathophysiological processes, coupled to quantitative analyses developed within the Institute for Mathematical and Molecular Biomedicine, and super-resolution imaging of protein network organisation, coupled to genomic analyses, of both normal and disease states.
- Thanks to awards from the BBSRC, **Parsons, Cox and Ameer-Beg** will collaborate together to build two new super-resolution light sheet instruments for analysis of 3D in vitro and in vivo model systems to study interactions between different cell types involved in inflammatory disease and cancer.

Muscle biophysics

The Muscle Biophysics section, led by **Ehler**, study all aspects of striated muscle function from the molecular, via the cellular, to the organismal level. They study the basics of muscle function in its smallest contractile unit, the sarcomere, and how gene regulatory networks define the fate of a muscle cell. The maintenance of the complex cytoarchitecture and regulation of protein turnover and disposal of damaged or mutant proteins is also a key area of interest, along with mechano-signalling that regulates muscle function. Skeletal muscle and interactions between cells and their surrounding tissue niche during limb development and establishment of muscle-nerve cell contacts are other key areas of interest. Section members study the genetic regulation of the development of the musculoskeletal and cardiac systems (**Hughes, Logan, Wardle, Zammit**), the pathways controlling the assembly and turnover of contractile structures (**Gautel, Ehler** (UoA1)) and the molecular mechanisms underlying muscle contraction and its regulation (**Brunello, Fusi, Irving, Kampourakis, Pfuhl** (UoA1)). These teams use genetic, cell biological, biophysical and structural approaches to enable analysis of the proteins responsible for signalling, and the structural integrity of muscle, its renewal from endogenous stem cells, and the impact of mutations that underlie the pathology of muscle. Some teams (**Ehler**, **Gautel, Irving, Pfuhl**) are also members of the School of Cardiovascular Medicine and Sciences and the British Heart Foundation Centre of Research Excellence, renewed (£6M) in 2019 for a further 5 years. This section currently supports four fellows, three BHF funded (**Brunello, De Nicola, Kampourakis**) and one Wellcome Trust (**Fusi**), all of whom progressed from postdoc to independence within the Randall.

Major achievements in the REF period:

We have continued our exploration of muscle function from the basic mechanisms of contraction to analysis of development and disease. Our recent discoveries include solving the molecular structure and hence establishment of crucial regulatory mechanisms for the Z-disc protein alpha-actinin (**Gautel)** and the discovery of a completely novel fundamental concept for the regulation of muscle contraction at the thick filament level, which rewrites textbook knowledge (**Irving, Fusi and Brunello** for skeletal muscle; **Brunello** for cardiac muscle). Using mouse and zebrafish models, the orchestration of muscle bundle formation during development (**Logan**) as well as mechanisms that regulate mesoderm and muscle formation were worked out (**Wardle, Hughes**). Other studies linked ultrastructural changes with pathological signalling in heart disease (**Ehler**) and explored disease mechanisms of FSH Muscular Dystrophy (**Zammit**).

Future plans:

- Our future focus is on exploring the basis of heart disease through detailed analysis of proteins such as myosin and titin at the structural (**Gautel, Pfuhl)** and functional (**Brunello, Irving**) level and using this new knowledge on muscle protein function and cardiomyopathy signalling to screen for new drugs to treat heart disease (**De Nicola, Ehler, Kampourakis**).
- We will also explore novel mechanisms that regulate contraction of skeletal and cardiac muscle at the level of the thick filament are analysed using X-ray diffraction (**Brunello, Fusi, Irving**).

- We will develop cutting edge model systems to study heart and skeletal muscle disease such as iPSC-derived cardiomyocytes in 2D and 3D culture (**Ehler**) and iPSC-derived skeletal muscle in 3D (**Zammit**). Studies will explore the role of muscle-connective tissue fibroblasts in congenital diseases (**Logan**) and analyse the role of activity, force and regulated translation in muscle growth (**Hughes**).
- Mechanisms of myogenic specification will be determined by identifying transcriptional complexes and gene regulatory networks required to drive heart and skeletal muscle progenitor cell fate (**Wardle, Zammit**). Fundamental translational work includes studies to understand the molecular basis of FHS Muscular Dystrophy (**Zammi**t) and of the structural basis of myopathies caused by sarcomeric, cytoskeletal and autophagy pathway gene mutations (**Gautel)**.

Research impact:
Research is the Randall is highly interdisciplinary meaning we are well positioned to contribute to a broad base of medical and technical challenges that sit outside the boundaries of academia, as well as extensive public engagement activities (detailed in Section 4). Our research has attracted >25 new national and international Industry partners and over the last 7 years that have driven development of innovative tools and new therapies with direct impact on the broader community. Most of these relationships are through company-led approaches to our PIs, underlining our international profile in this area. Some examples of these activities are detailed below.

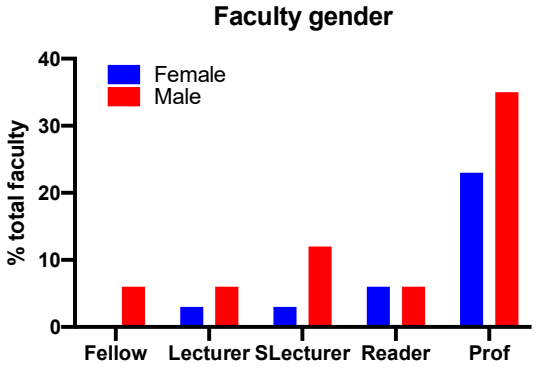
- **Ameer-Beg** and Ng (UoA1) have ***developed a novel imaging technique for visualisation of complex protein-protein interactions*** called Fluorescence Lifetime Imaging Microscopy Förster Resonance Energy Transfer (FLIM-FRET). FLIM-FRET has shown in tumour biopsies that certain protein combinations predicted either effectiveness or resistance to specific drugs and this technology can help target treatments to the right patients, resulting in reduced healthcare costs, reduced morbidity and improved survival. Drawn by this revolutionary technology, Pharma companies have funded FLIM-FRET projects to develop and evaluate novel cancer drugs and a spin-out company, Nanolinical, was created to further develop and commercialise this technique.
- **Gould** and Karagiannis (UoA1) ***identified an alternative family of antibodies (IgE) to treat solid tumours***. They developed the antibody from conception, revealing how IgE functions, through to translation into a Phase I clinical trial with promising results. This body of work has resulted in the creation of a spinout company, IGEM Therapeutics Ltd. This company has secured >£7m of investment and a patent covering antibodies of this class in three international territories.
- **Baron** ***developed a new process for recovering human fingerprint evidence on poached ivory*** to combat an estimated $23 billion a year illegal wildlife trade. Until then, fingerprints were not used routinely as a source of evidence on ivory or other poached animal items due to their high instability. Toolkits developed by **Baron** and the Metropolitan Police were funded by the International Fund for Animal Welfare and provided to law enforcement agencies in >40 countries where they are now in use by rangers, border officials and police at the front line. The team contributed to Government-sponsored technology intervention strategies, Parliamentary debates and provided support leading to poacher arrests using fingerprints for the first time. This technology enabled Interpol and the City of London Police to establish the first global fingerprint database for wildlife crime.
- **Fraternali** ***developed bioinformatic tools for analysis of clinical samples***. BRepertoire™ is an online platform that analyses the antibody profiles and has been used to monitor immune responses in autoimmune diseases, allergic responses and tumour-immune profiles from patients. In collaboration with **Gautel**, **Fraternali** has also developed TITINdb, a web-based tool to map mutations in the Titin gene that lead to types of muscular dystrophy. The titin gene is one of the largest in the human genome and the majority of healthy individuals possess one or more rare missense variants making it previously impossible to accurately map and track common pathogenic mutations. This tool has been used by clinicians in the UK, EU and US to map titin mutations and is now used for genetic prognosis and counselling for affected families as well as to define regions of this giant protein for therapeutic targeting.

- The ground-breaking structure-function work on IgE by **Sutton, Beavil** and **McDonnell** has ***led directly to the development of two novel anti-IgE drugs***: a biologic anti-IgE and a small-molecule anti-IgE drug (patents granted in 2020). Allergic diseases including asthma, urticaria and food allergies affect more than a billion people worldwide. All of these disorders utilise the molecule immunoglobulin E (IgE) to trigger pathological allergic reactions. These drugs, developed with industrial partner UCB Pharma, utilise novel inhibitory mechanisms, and are expected to be more efficacious and treat a larger group of potential patients than existing drugs with recruitment into clinical trials commencing in early 2021.
- ***Our development and application of advanced imaging has driven industry collaboration and investment*. Cox** has developed a number of advanced super-resolution image analysis algorithms and is currently at the late stage of negotiations with the global microscope manufacturer Nikon to commercialise this software for use worldwide by researchers. **Parsons** has 3 ongoing collaborations with Biotech companies (Amryt, Spinogenix and Paracrine), all of which focus on the application of advanced microscopy to define mechanism of action of first-in-class drugs for targeting the cytoskeleton in diverse disease processes.
- UoA5 researchers ***pivoted to apply their research skills to aide in the understanding of the molecular basis of COVID19*** during the 2020 pandemic period. **Bergeron** applied his extensive knowledge of ultrastructural regulation of pathogen entry to analyse a protein (Orf10) within the SARS-CoV-2 virus responsible for COVID19. Orf10, is only found in SARS-CoV-2, and not in any other coronaviruses and may be responsible for the asymptomatic period in infection, a critical factor in the COVID-19 pandemic. Bergeron, in collaboration with **Steiner** and Malim (UoA1) are using cryoEM to identify the molecular basis for Orf10 targets. This will reveal new factors that need to be degraded for the virus to replicate and could be exploited for the design of antiviral drugs. **Sanderson,** funded through a rapid response 'King's Together' internal pump priming award (£20k), established a collaboration with Rosta and Cobb (UoA8) to rationally design and test potential drugs targeting the SARS-CoV2 helicase using a structure-function approach. This ongoing work will provide means to validate therapeutic mode of action prior to pre-clinical/clinical testing.

Research Integrity:
We are strongly committed to compliance with the Concordat on Open Research Data, and King's are a signatory on the San Francisco Declaration on Research Assessment and the Concordat to support Research Integrity (see REF5a). Our practices in Research Integrity have evolved in the Randall to ensure we are adopting robust procedures for investigating and resolving allegations of research misconduct to incorporate the requirement to notify funders at the stage of an informal investigation should it be deemed necessary. We have clarified the procedure on the categorisation of allegations that are not upheld fully but have substance, to make it clear whether research misconduct has been committed or is more reflective of poor practice in research. We work closely with the Research Integrity team, Centre for Research Staff Development and Centre for Doctoral Studies to offer training to our research staff in these important areas. These changes have led to improved online visibility and provision of a generic mailbox for any queries related to research integrity. King's have committed extra resources for this, with a new Research Integrity Manager role dedicated to this area, and Academic Dean for Research Governance, Ethics, and Integrity. **Parsons** acts as Faculty Research Integrity Lead to actively promote, educating and administering our Strategy in this area across all 7 Schools.

2. People

Staffing Strategy

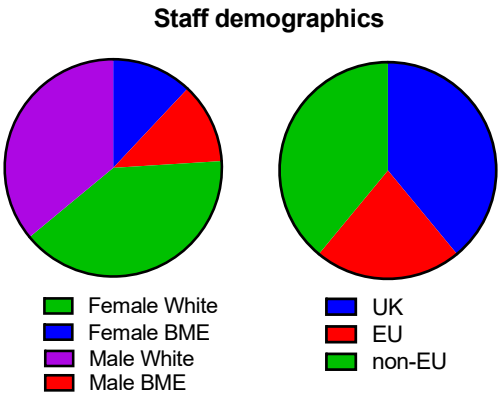


Currently, the Randall faculty staff is comprised of 47% Professors, 14% Readers; 8% Senior Lecturers; 17% Lecturers and 14% Fellows (35%F, 65%M; see graph). Our recruitment strategy is designed to maintain and strengthen existing areas, nurture talent and to develop new teams to address emerging questions in our research focus areas of cryoEM, optical biophysics and bioinformatics. This is evidenced by the high number of new fellowship holders in UoA5 in the current REF period: **Cox** (Royal Society Senior URF), **Fusi, Dodding** (Henry Dale), **Iskratsch**, **Brunello, Sun, Kampourakis** and **de Nicola** (BHF) and **Sanz-Moreno** (CRUK). Of these, **Cox**, **Brunello** and **Kampourakis** have transitioned to tenured Faculty positions within the Randall and **Sanz-Moreno, Caudron and Iskratsch** moved to QMUL in 2018/9 and **Dodding** to Bristol in 2018 to take up tenured posts. We have additionally recruited 5 new Group Leaders as tenured academic staff since 2014: **Atherton, Bergeron and Fleck** to strengthen our research base in electron microscopy/structural cryoEM; and **Rosenblatt** and **Oliferenko** who bring world-leading expertise in molecular mechanisms underpinning cytoskeletal dynamics. We provide long-term support to our research fellows with the goal of facilitating transfer to a HEFCE-funded position when their research group is well established. This includes mentoring and regular progress reviews, advice on funding applications through workshops and peer-to-peer learning groups, initial embedding in established host labs where appropriate, and access to shared research facilities/infrastructure. In addition to the fellowship track, our strategic appointments at senior level (**Rosenblatt, Bergeron, Fleck, Oliferenko**) came with an established research group supported by grants. The appointees at more junior levels who need to build a research group on their arrival are supported to do so in the same way as described above for Fellows, with reduced teaching commitments to ensure they have dedicated research time.

Equality and Diversity

Our commitment to EDI is embedded across the Randall governance, operations and culture. In 2014, the Randall secured its own Athena Swan Silver Award and in 2018 it helped to secure a Faculty-level Athena SWAN Silver Award. We are passionate about the role and importance of leadership in visibly championing our commitment to EDI principles and to ensuring EDI principles feed into all decision-making and operations. A Faculty Vice-Dean for Development, Diversity & Inclusion (DDI) was created in 2017 and they sit on the Faculty Executive and ensure that EDI principles and priorities inform strategic planning and outcomes. The Vice-Dean works with the embedded School DDI Teams and chairs the Faculty DDI Committee, represented by Faculty Academic and professional services DDI Leads. The DDI Team/Committee oversee implementation of the Faculty Inclusion Action Plan. **Logan** and **Ehler** both sit on the School DDI committee and in this role, they champion and embed talent development, EDI principles and processes across all the activities we undertake in the Randall.

Awareness of our commitment of EDI is high across our UoA. The 2019 King's Staff Survey showed 96% of our staff were aware of our commitment to EDI; 91% agreed we were committed to an inclusive environment; and 92% agreed we acted fairly, regardless of protected characteristics. Our recent Staff survey also showed that 95% of staff are aware of Athena SWAN and 89% had undertaken Diversity Matters training. We have also improved key transition points for all research and support staff, including introducing comprehensive induction packs, including dedicated time for career progression and impact generation discussions in our PDR process, as well as improving awareness and access to flexible working. This has been particularly important during the COVID19 pandemic era, where many of our research staff (particularly 'dry lab' bioinformatics research teams) have had to adapt to working from home. In recognition of this, we provided funds to cover costs of establishing an appropriate home working environment (eg: monitor, ergonomic



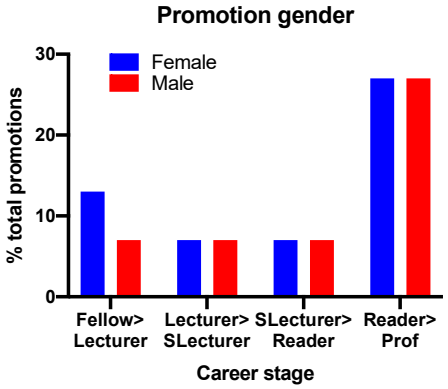
chair) to all staff who required it. Indeed, our recent staff survey shows an increased proportion (73%) of staff taking up informal flexible working and we are strongly committed to supporting individuals who choose to work from home where possible, and who have caring or other commitments that require working flexibly during the pandemic period and beyond. Our research staff community are highly diverse in terms of origin and ethnicity with >20 different nationalities represented as shown on the left.

Research staff training and career progression

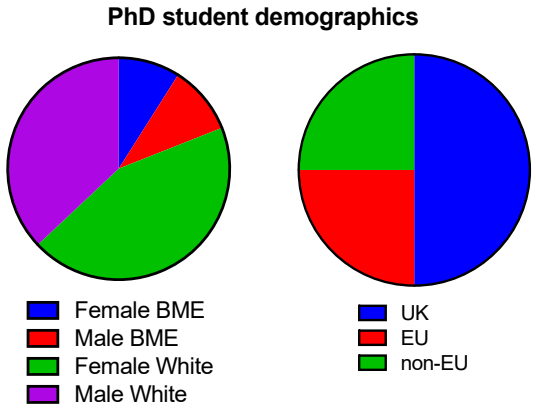
All research staff in UoA5 associated teams are provided a welcome induction pack, orientation guidance and meeting with our professional services teams when they start. They all participate in our annual performance development review (PDR) process, which focuses on their personal development. Our latest staff survey showed 83% of new starters agreed their induction was welcoming; and 84% agreed that career development was discussed effectively at PDR. We introduced a mentorship programme in which researchers are supported by experienced PIs in other groups, either within the Randall or other Departments/Schools. A 'post-doc champion' represents the researchers at Randall and School level and helps develop bottom-up initiatives, like the Guy's Researchers' Society, which organise seminars/workshops on careers, entrepreneurship and research. Our PhD students and post-docs are also encouraged to assist with teaching (tutorials/practicals) for <30h a year, for which they receive accredited training (10 credits of 180-credit level7 Postgraduate Certificate in Academic Practice). Research fellows gradually increase teaching to reach the level of a first year academic. All our researchers are supported in preparing for wider career opportunities (Principles 3-5 of the Concordat) with generic, science specific, and post-doc specific courses. We also promote EDI through Department-led participation in KCL-wide activities. We provide a wide range of strategic programmes/networks to promote equality of opportunity and achievement, e.g. the B-MEntor scheme for Black and Minority Ethnic group staff, the Career Break Fund for academic staff returning from a career break (e.g. maternity/paternity, adoption leave), the Women's Network, and the Springboard Women's Development Programme for research staff.

Our approach to EDI in the Randall strongly aligns with the Faculty plans for a commitment to "take collective responsibility and accountability for development and inclusion of research staff", and Faculty Vice-Deans for DDI, Research and Impact & Innovation (**Parsons** holds the latter role) have specific responsibility for supporting research staff in these areas. We have reviewed the appraisal paperwork and guidance in consultation with our research staff, to ensure the process facilitates constructive discussion around mentoring, training and progression. In 2015, we established a Faculty Research Staff Network, which connects research staff and provides peer-mentoring, information about training/progression opportunities and representation on Faculty/School decision-making committees. We proactively communicate King's provision for mentoring and training, offered by the King's Centre for Research Staff Development, host workshops on grant and fellowship application writing, provide travel awards and enable local training/development initiatives across our departments through funding, advice and training via our Randall DDI Team.

16 members of our Faculty (>40%) have been promoted in the current REF period (9F, 7M) and constructive promotion discussions take place at annual PDR meetings to provide guidance on routes to progress to the next level. Our promotion process has evolved over the past 7 years to formally recognise individualised levels of achievement and commitment to education, research and impact to ensure all activities are properly considered and weighted appropriately. Our new Faculty members are appointed on 3-year probation and are guided through this process by their dedicated mentor through regular meetings and evaluation of progression criteria.



Research students



Of the students who were in their first year in 2014, 2015 or 2016, 100% successfully submitted their PhD's within 4 years. We currently have 43 full time and 2 part-time PhD students within our labs and an additional 15 who are registered in other research centres outside of the Randall but conduct the majority of their research in the Randall. PhD students are all on 3- or 4-year funded programmes. 21 students within the return period are/were funded by various research councils (MRC, BBSRC, EPSRC, STFC) with an additional 6 funded through Industrial CASE collaboration awards (supported by UCB, Zeiss, Tocris, Cairn, Novartis and MedImmune). We apply the principles of EDI in our PhD student recruitment and throughout the environment in the Randall. We maintain a continued balance in our PhD student gender ratios, with ~20% of our students identifying as BME (see graph). Half our PhD students are from the UK, with the remaining students split equally between EU and non-EU nations (see graph) with 13 nationalities currently represented in our cohort. Notably, Randall hosts the Darwin Trust of Edinburgh PhD programme; we have elected to restrict recruitment to this programme to candidates from Africa to increase our representation of PhD students from this region. To date we have recruited 5 students from Kenya, Nigeria and South Africa.
All new PhD students in the Randall have a welcome lunch to be introduced to the Head of School, PGR lead, Education Operations Officer, departmental PGR coordinators and student reps. Structures of Thesis Committees (TC) and progression are explained, as are roles of PGR coordinators, lead and departmental/School support for PGR students. We inform students and supervisors on expectations, the PhD journey, training for teaching, Faculty travel awards, membership of professional societies, bullying/harassment and the School blog. A Randall-specific mandatory induction is focussed on health and safety and is signed off by the Technical Manager before students are start laboratory work. All new Randall PhD students are also assigned a 'buddy' from current students to support their arrival and integration into the department.

All academic staff must pass a course on PhD supervision with compulsory refresher online interactive webinars every 2 years. Selection of students is based on a competitive interview by committee, using Graduate School guidelines for consistency. Students have 2 supervisors, 35% are shared with teams outside the Randall within King's or other London HEI's/Crick. This offers opportunities for the students to experience alternative environments and broaden their academic networks. The Randall has a Postgraduate Advisory Committee chaired by its Postgraduate Coordinator to oversee student progression. Every student has a TC, comprised of supervisors, two external experts and a Chair. TCs meet every 6 months, and these provide an important forum for the student to present their findings, review training and seek input on future plans and

additional training/mentorship if required. Progress reports are completed online every six months (from month3 onwards) by the student, supervisor and TC Chair. At the end of Year1, each student writes a report that is examined by the TC and gives an oral presentation before upgrading from MPhil to PhD. All students must attend programmes on scientific management (project design, data handling, ethics etc), and generic skills (communication, networking, teamworking etc). A postgraduate coordinator serves on the TC of each Randall PhD student and a Confidential Advisor support service is provided where students can discuss issues of concern with a member staff outside their Department. The Faculty also has a PGR Student Welfare academic lead who provides independent support when required.

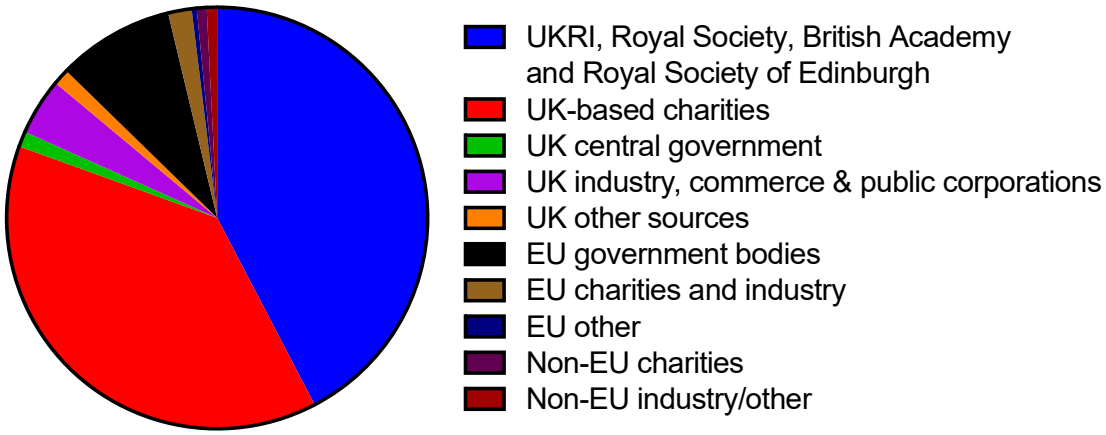
The Centre for Doctoral Studies is a King's-wide centre with responsibility for the postgraduate research student experience. The mission of this centre is to equip our research students to excel by setting and enhancing standards, providing support, training, and improving provision for postgraduate students. Support for researchers includes a programme of >300 free workshops annually. We offer an online PGR wellbeing toolkit, and a Stress management PGR wellbeing und from 2019. King's also offer free premium LinkedIn accounts for PGR students; all Randall students are strongly encouraged to establish a profile to boost their visibility to external employers and better develop their global networks. Our efforts have led to 48% of our PGR students during the REF period undertaking internships /shadowing within non-academic sectors, many of which have led to future employment in these areas.

Our ethos in the Randall is one of open and collaborative research, with the students taking full advantage of the communal lab philosophy and open access to shared equipment and core technical support. In addition to developing a close working relationship within their own group (lab meetings, journal clubs and presentations), they also have their own PhD seminar/journal club program and PhD student pizza nights that they operate independently of supervisors. School student reps organise an annual careers day, inviting PhD graduates working in diverse sectors to provide advice on future direction. A highlight of the year is our School annual postgraduate symposium where the final year students give talks and others present posters, judged by a panel of postdoctoral researchers with feedback given after the event. We also award an annual £250 prize in memory of Jeni Fordham (a PI in the Randall from 1974-2009) to the PhD student who has made a particular contribution to the lives/ morale of the Randall that year. All students regularly present at national and international conferences, with designated funds available for this. External visiting speakers (leaders in their fields) meet the students over lunch to develop networking skills and build confidence. Notably, in the 2019 Postgraduate Research Experience Survey, Randall PhD students reported 89% satisfaction with their overall experience, compared to an overall KCL score of 79%, underlining the success of our strong focus on inclusivity, support and creating a nurturing research environment.

3. Income, infrastructure and facilities

Income:

Annual research income for the UoA5 returnees within the current REF period came from a variety of sources (see below) and was higher annually than for the previous period (2008-13), with an average annual income of £6.59M per annum compared with £4.8M previously.



Total=£46.16M

UKRI and UK charities are our major funders. Research Council income increased ~20% to ~£2.7Mp.a. Income from UK-based Charities was also increased ~14% to £2.49Mp.a. Substantial notable investments in our portfolio include 4 MRC programme grants, 3 Wellcome Investigator Awards, 3 BBSRC SLoLa awards, 2 ERC Consolidator grants, a CRUK senior fellowship and a Wellcome Collaborator award. The remainder is accounted for by income from UK government, EU and industry. These figures do not include major cross-School/Faculty funding initiatives such as our two NIHR Biomedical research Centres (total £130M) and the BHF Centre for Research Excellence (£9M in the 2013-19 period, recently renewed for an additional £6m) of which we are major beneficiaries.

In addition to grant funding, our extensive interactions with Industry have led to ~£0.8M p.a. in-kind investment from our partners (including AstraZeneca, Zeiss, UCB, MedImmune, Nikon, JEOL, Olympus and Novartis). These funds have supported activities such as high content drug screening for cancer and inflammatory disease, new high-resolution microscopy instrument development and generation of new modified chemical compounds for optogenetic analysis of signalling. Nine UoA5 returnees also act as consultants for Industry and through this, have influenced changes in commercial pipeline development and strategy.

Leadership and investment in infrastructure and sustainability:

Our multidisciplinary organization into Research Departments and Centres facilitates a culture of maximal sharing of infrastructure and facilities, both within and between Departments/Centres, and more widely across the College through the centralized Core facilities Analytical Platforms Board that co-ordinates such facilities across King's (of which **Parsons** is a member). Within the Randall, our policy is to use shared facilities to disseminate critical mass in specialist fields and to exploit synergies that arise from our multidisciplinary approaches. There is a high level of exchange between labs of technologies, practical expertise, reagents, and ideas, and instruments are available to all research staff through an online booking system. Infrastructure is available to support the very wide range of work that we undertake, from detailed studies on molecules to whole animal models, using a range of biophysical, structural, cell and molecular biology techniques. Our open-access policy allows early career researchers to access state-of-the-art instrumentation to obtain preliminary data for grant application submissions. Animal facilities in close proximity to our labs are available for full phenotypic characterization of Drosophila, zebrafish and mice and for all of the surgical procedures required for gain and loss of function studies. Mice have also been moved into individually ventilated cages to secure a much higher level of biosecurity.

Infrastructure types
Three returnees from the Randall have key leadership roles in the establishment, management and Scientific direction of 4 of the 8 major core facilities at King's. These PI's have also been heavily involved in securing large-scale investment for these facilities, through external grant funding and collaborations with key Industrial partners. In recognition of the strategic importance of remaining at the cutting edge of biophysics and optical technology to support our excellent research base, Kings have prioritised investing in these technology platforms. Through attracting significant external funding, the total internal and external investment in these platforms since 2014 has been £23.5M: £11.3M (CUI), £4.1M (NMR), £5.3M (NIC) and £2.8M (MIC). The 4 facilities that we have oversight of are:
Nikon Imaging Centre (**Parsons**)
Microscopy Innovation Centre (**Parsons**)
NMR Facility (**Conte**)
Centre for Ultrastructural Imaging (CUI) (**Fleck**)

Our facilities at King's for optical microscopy are probably unmatched in the UK, and much of this activity has been led by UoA5 returnees. We have led the development of the **Nikon Imaging Centre** (NIC) at King's, the only such Centre in the UK and one of 9 globally, which provides 12 state-of- the-art instruments currently including N-SIM and N-STORM Super Resolution microscopes in a partnership agreement (2011-2021; with the 3rd 5-year contract with Nikon signed in Dec'20) that allows continuous upgrading and replacement as new instruments are developed. Nikon have thus far invested >£6M in the NIC@King's and in 2018, designated this facility as a European Centre of Excellence in Super-resolution microscopy. Our physicists (**Ameer-Beg, Cox** and Suhling (UoA9)) and biophysicists (**Spillane, Owen**) are also working with Industry partners to develop new applications in super-resolution microscopy with UKRI funding. Many other microscopes are located within the Randall, including 2 spinning-disc and 5 confocal microscopes. The Randall continues to pioneer cutting edge developments in optical imaging (e.g. FRET/FLIM, single molecule, mechano-imaging) and this recognised excellence has attracted numerous collaborative projects within King's and other leading research teams across the world.

The **Microscopy Innovation Centre (MIC)** grew from this extensive microscopy instrument development activity across King's. The MIC was established by **Parsons, Ameer-Beg and Cox** in April 2018 with £0.6M of investment from King's to act as a unique hub for innovation and provision of advanced imaging solutions developed by King's academics to the research community. Optical microscopy development is moving faster than commercial pipelines, meaning biomedical researchers rarely have access to truly cutting-edge imaging technology, restricting the potential impact of these instruments. Commercially available microscopy platforms are limited in functionality and do not offer the potential for easy adaptation to suit bespoke experimental set-ups. The MIC bridges this gap and makes bespoke optical instrumentation accessible to non-experts to achieve cutting-edge, transformative solutions to biological challenges. 14 associated industrial partners have donated hardware for development in the MIC totalling over £2.2M, and additional partnering with 5 SMEs has enabled placement of instruments into the MIC on long-term loan to enable interactions with a broad range of users and receive essential feedback for future development. The MIC currently supports users from King's as well as 4 others HEI's across the UK and has secured £0.7M of funding to date through external grants from BBSRC to develop new instrumentation for delivery to the life sciences community.

The King's **NMR Facility** provides research scientists with access to cutting edge nuclear magnetic resonance spectrometers equipped to address a range of problems of biological interest. The Facility supports researchers by maintaining a pool of expertise in biomolecular NMR spectroscopy and providing training and assistance as required. A team of King's College London academics led by the NMR Facility Director **Conte** were awarded a multi-user equipment grant from Wellcome and the British Heart Foundation to develop a state-of-the-art NMR Facility for high-resolution, high-throughput applications in structural biology, metabolic profiling and drug discovery. The £3.31M funding, including a £1.31M investment from King's, has provided new 800MHz (18.8T) and 600 MHz (14.1T) NMR spectrometers with automation capabilities and builds on the existing

scientific excellence in the Randall, Centre for Biomolecular Spectroscopy and King's BHF Centre of Research Excellence.

The **CUI** underwent a transformative programme of refurbishment and investment since the 2014 REF and following recruitment of **Fleck** in 2014 as the new CUI Director. King's centrally provided £1.5M in 2013-2015 to undertake the refurbishment required to transform the CUI into an environment suited for high resolution EM with cryo sample preparation. King's invested a further £1.7M in new equipment, and thanks to in-kind contributions worth ~£3m from JEOL, Leica and other Industrial partners, and two Welcome Trust Equipment grants (£1.6M). This investment has resulted in the state-of-the-art facility in the quantitative ultrastructural analysis of cells and tissues, transforming a wide range of research of King's and its Health Partners. Research staff are trained to work with CUI staff to optimize tissue preparation, image acquisition and quantitative analysis. A cohort of 'super user' research staff trained to be independent in pursuing their projects is emerging in groups with a long-term commitment to EM analysis. The range of expertise and equipment available in the CUI now enables novel and transformative analysis of biological samples. This scientific progress owes much to our collaborations with external academic and commercial partners, and our partnership in the Rosalind Franklin Institute (RFI), Nikon Mathematical Research Division (who fund a PDRA to develop 3View and FIB-SEM tomography) and a new collaboration with Michael Spraling (King's Informatics, UoA11).

Fleck is also King's lead for the RFI, funded at £106 million for the first 5 years. King's is a principal "spoke" supporting correlative EM in two major work streams: to develop pulsed electron source TEM; and to develop correlation technologies linking temporal and spatial data across extended dimensional scales. This major opportunity for King's provides benefits in early adopter access to new instruments, influence over instrument development and high impact collaborations with RFI. King's collaborations on this initiative also include AI innovation (Informatics), soft matter research (Physics/Engineering/Chemistry) and multiscale correlation (Life Sciences). Longer term, our partnership in RFI will allow us to build a stable presence of staff and equipment in the Institute to develop advanced sub-tomographic imaging, currently available in a handful of institutions worldwide.

We also partner with other London-based Universities and with the Crick in major investments and initiatives in research facilities. The **London Centre for Nanotechnology (LCN)** is a UK-based multidisciplinary enterprise operating at the forefront of science and technology. The LCN began as a joint venture between University College London and Imperial College London in 2003, and from 2018 King's joined the collaboration to further extend the capabilities and deliver access to our state-of-the-art facilities and training to research staff within partner London HEI's. The Centre accesses and focusses combined skills of all three universities, has strong relationships with the broader nanotechnology/commercial communities and is involved in many major collaborations, nationally and internationally. Within the Randall, **Parsons/Fleck** both sit on the King's LCN Steering Committee, and **Parsons** on the LCN Executive Strategy Board. Within these roles they provide leadership in strategic development of the LCN and co-ordination of access and collaboration across London.

The **London Centre for cryo-Electron Microscopy (LonCEM)** brings together researchers from Imperial College London (IC), Institute of Cancer Research (ICR), King's College London (KCL), Queen Mary University London (QMUL), the Crick and provides a high-resolution cryo-EM facility to enable excellent research, collaborations and training. The Centre was established following a £3M multi-user equipment award led by IC with ICR, KCL and QMUL as partner institutions. All members contributed matching funds. This allowed the acquisition of a state-of-the-art Titan Krios transmission electron microscope installed at the FCI. The LonCEM opened in March 2020. **Steiner** and **Gautel** are co-Is on the Wellcome Trust grant and **Steiner** represents King's in the LonCEM Management Committee. **Sutton** co-ordinates access to the Harwell complex Diamond beamlines for the entire King's structural biology community. **Fraternali** also sits on the selection board of the EPSRC supercomputing facility in Cambridge, of which King's is a partner.

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

All of our returnees are heavily involved in the peer-review process for leading journals and national/international grant awarding bodies and regularly attend conferences as invited and keynote speakers. All are external examiners for BSc courses and PhD theses. Many are on national and international advisory boards and collaborate extensively with Industry. The above sections provide evidence for the multidisciplinary and collaborative nature of our research with both academia and industry. Some examples of our other achievements and responsibilities, collaborations and reviewing for journals and funding bodies are highlighted below.

Fellowships of national and international learned societies, prizes and awards:
In recognition of our research excellence and standing within the international community, over half of the UoA5 returnees have received highly competitive personal fellowships or significant awards/medals from learned societies over the return period. The breadth and diversity of awarding UK and international bodies further underlines the interdisciplinary nature of our work. Notable fellowships among the 14 awarded in the REF period include Wellcome Trust Investigator (**Eggert, Oliferenko, Stramer**), ERC (**Gautel, Stramer, Eggert**) Royal Society (**Cox**) and BHF (**Iskratsch, Sun, Kampourakis, Brunello, deNicola**). Additional prestigious awards/honours have been given to 15 other PIs including FRS (**Ridley**), FRSB (**Fraternali, Ridley, Parsons, Eggert**), FRSC (**Eggert, Fraternali**), FRCP (**Fleck**) and FRMS (**Parsons**).

Funding Bodies and Advisory Board memberships: In recognition of the very strong international standing in our respective research fields, UoA5 returnees are regularly invited to participate in major UK and international funding agency boards and scientific advisory panels. Within these roles, our PIs contribute to final decision-making on funding outcomes, advising on major investment strategic direction and input into future funding strategy within the UK. 14 PIs are members of national funding panels, notably including MRC (**Parsons;** Chair), **Ridley**), BBSRC (**Parsons, Pfuhl, Ameer-Beg**), EPSRC (**Bergeron**), Wellcome (**Gautel, Eggert**). 10 PIs sit on 15 international funding panels including ERC (**Fraternali, Eggert**), Swedish and Finnish Research Councils (**Parsons**), DFG (**Ridley**) and Hong Kong SAR (**Jones**). 12 PIs sit on UK/International Advisory Boards including the Francis Crick Institute (**Irving**), MRC/STFC Strategy Boards (**Parsons**), RSC Council (**Baron, Eggert**) and Leibnitz Intitute Berlin (**Eggert**).

Research consortia leadership and advisory roles:
In addition to contributing to strategic direction of funding, our returnees are also directly involved in leading or participating in national and international research collaboration networks, all of which are cross-disciplinary, inclusive initiatives aimed at strengthening community engagement, knowledge sharing, training and research excellence. 4 returnees lead National consortia/networks (**Parsons, Fraternali, Steiner, Irving**) that drive inter-disciplinary research activity in computational and bioimaging fields. **Baron** and **Frascione** also lead two different international consortia in forensic science.

Editorial Board memberships:
In recognition of our strengths in research excellence and integrity, over a third of our returnees have senior editorial positions or are members of editorial boards of leading international journals where they play an essential role in contributing to decision-making on scientific publishing across a broad base of fields. 5 of our returnees are Editors-in-Chief (**Parsons, Gautel**) or Senior Editors (**Fraternali, Ehler, Rosenblatt, Parsons, Gautel**) for leading journals in their fields. An additional 15 PI's are on Editorial Boards of major journals, including Cell, EMBOJ, Journal of Cell Biology, eLife and ACS Chemical Biology.

Courses and Conference organisation:
As highly active members of the international scientific community, our returnees play important roles in initiating and organising prestigious conferences and workshops in their respective fields. 12 UoA5 returnees have organised national conferences in the past 7 years, and an additional 12 have organised International conferences, including prestigious Gordon Research Conference (**Gautel**), ASCB (**Parsons, Oliferenko**), FASEB (**Sutton**) and EMBO (**Spillane**) meeting series.

Public Engagement:
Our returnees are dedicated to, and passionate about, engaging with the broader community outside academia to enthuse, inspire and educate about the research we undertake. A particular priority of our outreach strategy is to connect with underrepresented minority groups at schools, to encourage more interest in pursuing careers in interdisciplinary STEM subjects. Our activities in this area reach individuals from a very broad demographic base and take a range of forms spanning arts, media, exhibitions and lectures:

- King's Scientific Training for Aspiring Research Scientists (STARS); lead by **Parsons** in collaboration with the Mayors Fund for London. 20 pupils from inner London schools with poor track records of higher education follow-ons come to the Randall for a week of intensive lab-based scientific training. The STARS programme has now been running for 6 years and we remain in contact with the pupils, 85% of whom have gone onto higher education in Medicine or Biological Sciences.
- School visits (**Parsons, Gautel**) to teach and inspire pupils about biophysics, microscopy and cell biology, as well as conducting mock interview for those applying for Medicine programmes. Visit to Telanaga Social Welfare Residential School, Hyderbad, India (2018) to speak about science careers (**Hughes).**
- In partnership with the Royal Microscopical Society, **Parsons and Cox** undertake outreach activities including oversight of the Microscopy Activity kits, annual participation in the Big Bang evens and the 'learning Zone' embedded within the MMC series of microscopy meetings).
- Scientific expert for Three Days of Fat, a series of 'live' art-science experiments by Thought Collider (**Oliferenko**)
- Originator and host of annual Rosalind Franklin Prize visit by 6th form students to encourage access to University (**Hughes)**
- 'Pint of Science' talks, 2015-20 (**Bergeron, Fraternali, Parsons, Stramer, Logan**)
- Maths Summer School and the in2science scheme for underprivileged pupils (**Pfuhl**)
- Muscular Dystrophy UK Patient information day: Lay talk about muscular dystrophy to patients, carers, stakeholders and fund raisers (**Zammit**)
- Collaboration with Wellcome library to restore and archive historical scientific material and presented on Radio 4 (**Stramer**)
- "Dynamic Symmetry" at the Royal Society Summer Science Exhibition 2016 and "Aperiodic Patterns and Forbidden Symmetry" at the Royal Society Summer Science Exhibition 2017 (**Sutton**)
- **Baron** is highly engaged in outreach activity, examples of this include: live BBC radio show (2016) as invited guest on 'In Our Time' with Melvyn Bragg; live radio interview on 'Talk Radio Europe' in 2019; feature on BBC 'One Show' in 2018 discussing forensics; documentaries (Netflix on river water quality in 2020 and Channel 5 on Cocaine Dealers, 2018); 2019 Sky News headline feature on cocaine use in London; Interview in Evening Standard, 2019; Invited Lecture "Stopping the Ivory Trade", New Scientist LIVE, London, 2016; Invited Lecture "New forensic tools to combat ivory poaching" Patron evening, The Royal Institution of Great Britain, 2016; UK Foreign & Commonwealth Office Invited Workshop "New forensic tools to combat ivory poaching" British Consulate-General, Hong Kong, 2018

Sutton is highly active in promoting public awareness of the history of the structure of DNA with respect to King's and Rosalind Franklin. Examples of his outreach work include: Scientific advisor to the West End production of the play "Photograph 51" (2015); BBC Radio 4 interview for "Last Words" (2015); BBC Radio 4 interview for "Science Stories", DNA's Third Man (2015); Co-producer of "DNAted", within the Fabrication Festival: installation, filmed interview, panel discussion at Somerset House (Oct 2015); Minerva Scientifica "The Franklin Effect" to promote women in science (2015-16); British Science Week (March 2016); Co-producer of "Spit Crystal" installation and events, filmed interviews, YouTube video, part of "Mouthy" for Science Gallery London (2016); Public engagement hands-on event, "Through the Looking Glass: the Science and Art of Mirror Symmetry" at Bush House Arcade (2018); Contributor to "Viewing the Invisible", BBSRC-funded public engagement project, portrait and sculptures exhibited at Bush House with event at the National Portrait Gallery, YouTube video (Sept. 2019).