

**Institution: University of Birmingham (UoB)**

**Unit of Assessment: 3**

## 1. Unit context and structure, research and impact strategy

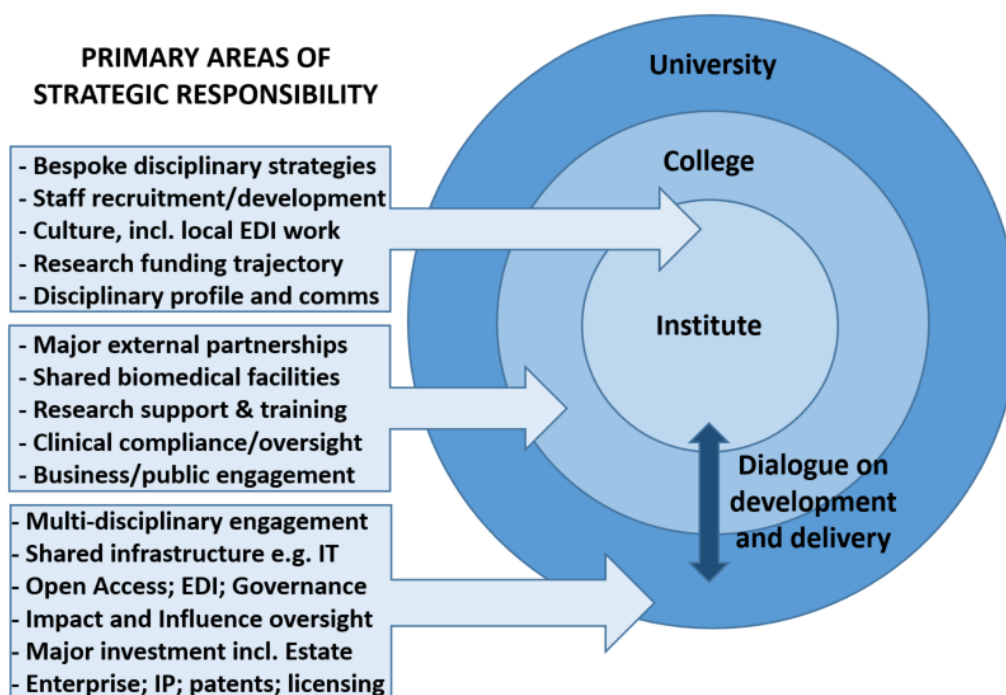
(Submitted names *italicised*)

### 1.1 Overview

The environment for UoA3 within Birmingham (comprising Dentistry, Nursing and Pharmacy) has undergone transformational change since 2015, driven by academic reorganisation, sustained investment in people and infrastructure and an embedded open culture of ambition and diversity.

### 1.2 UoA3 Context and Structure

UoA3 comprises three of the five Schools within the **Institute of Clinical Sciences (ICS)** in the College of **Medical and Dental Sciences (CMDS)**. ICS is linked strategically to the University as depicted in Figure 1.1. UoA3 comprises 45.3 FTE academic staff returned in REF2021 and contributes to the majority (>90%) of the teaching delivery/support to 2,000 dental, nursing and pharmacy students. After a peak in 2014/15 our research income has remained steady at around £2.5m pa, growing in 2019/20 to £2.7m. As a measure of research volume, our publications doubled from 83 in 2014 to 166 in 2019.



**Figure 1.1.** Co-ordination of strategy and delivery across institutional hierarchy

Following REF2014 the University instigated a strategic *Life Sciences Review* to increase the breadth and power of research outputs and impact to that commensurate with a leading global University (Figure 1.2).

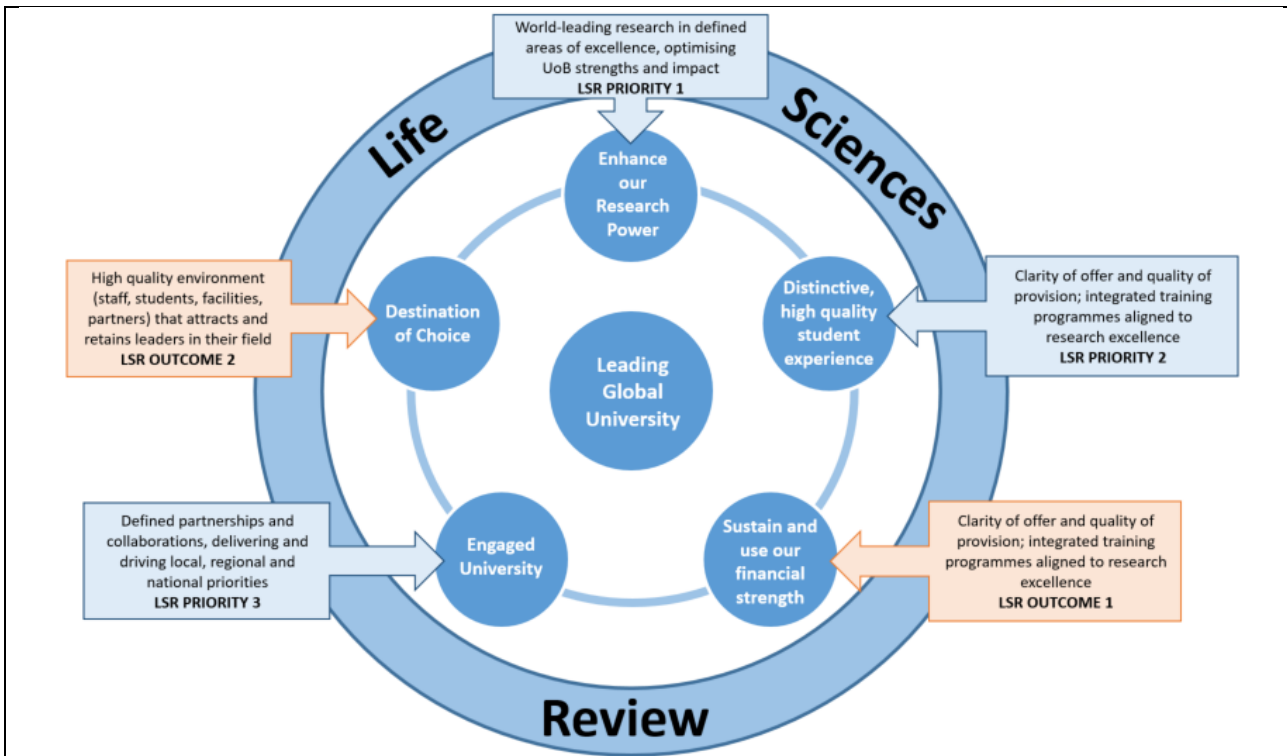


Figure 1.2: 2015 Life Sciences Review

As a result the original five CMDS Schools returned in REF2014 were reorganised in 2015 into eight Institutes (Figure 1.3). The formation of ICS resulted in integrating the School of Dentistry, which was returned alone in UoA3 in REF2014, with the new Schools of Nursing (est. 2014) and Pharmacy (est. 2012), facilitating an organic concentration of critical mass and expertise and stimulating cross-discipline collaborations.

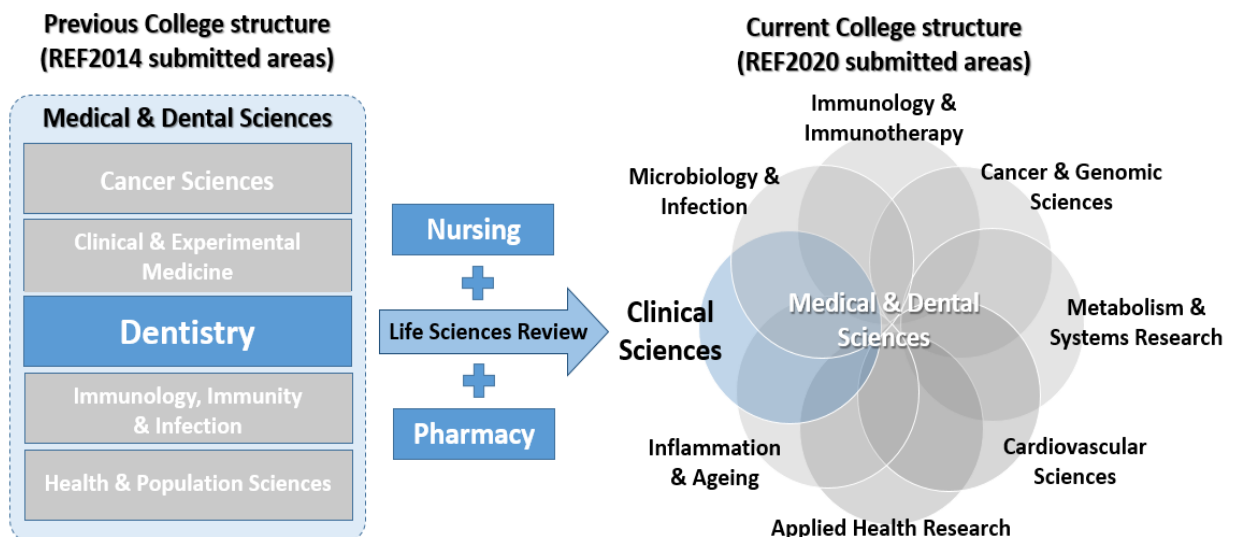


Figure 1.3. Remodelling of CMDS (UoA1/2 in grey).

This approach offered a number of advantages including ensuring a primary focus on research; as well as increased opportunity for smaller, nimble research groups and clusters to respond rapidly and effectively to national and international opportunities. ICS is the largest, most complex and diverse institute, with over 200 staff, 139 with academic contracts.

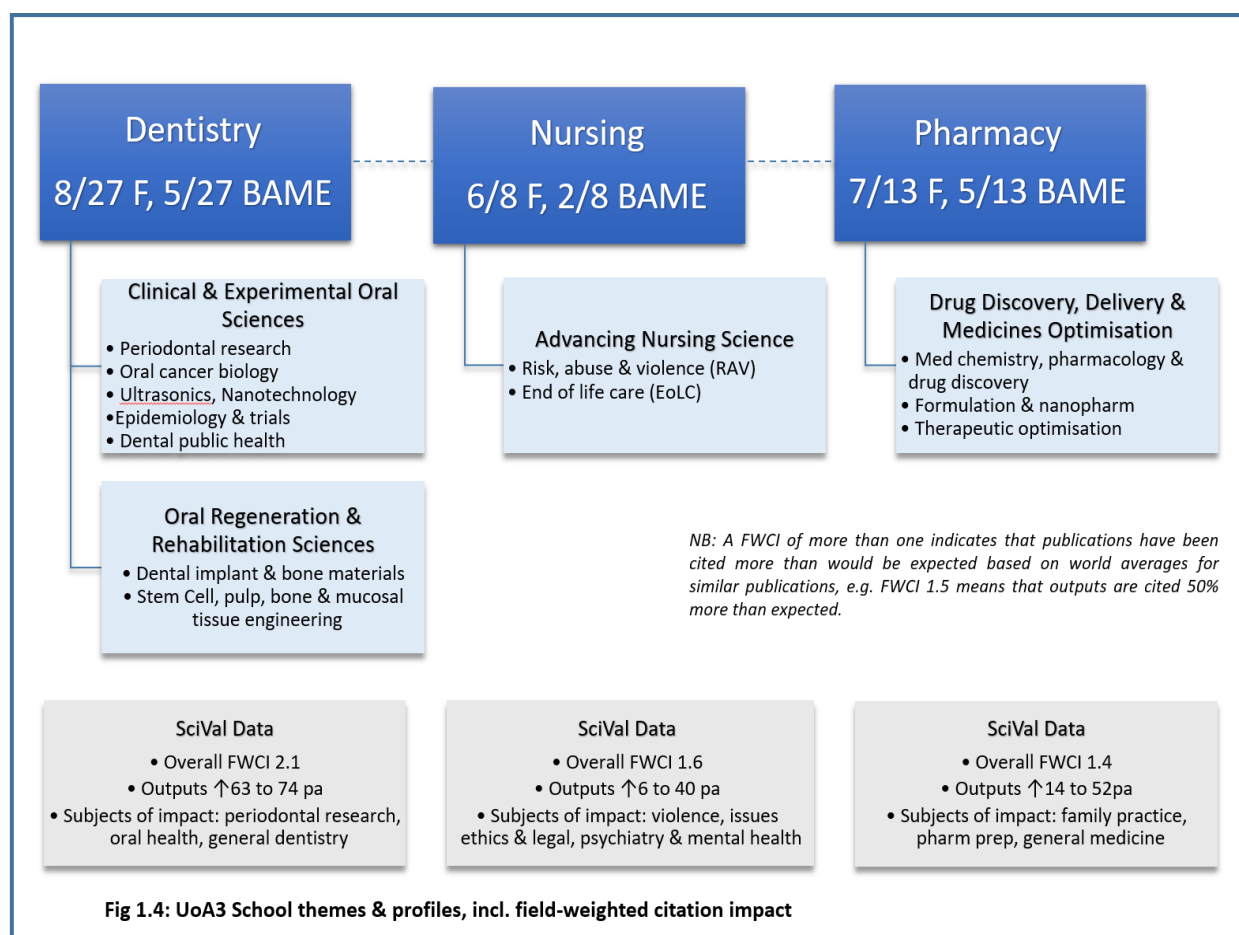
**1.3 Research groups** Each UoA3 School addresses distinct discipline-related research challenges, but our scholarship has a common focus on benefiting human health, wellbeing and welfare. Our research is demonstrably interdisciplinary, spanning the full translational spectrum from discovery science through to measurable impacts upon health and social care delivery (Section 4). Our strategy for growth, innovation and impact (Section 1.5-1.8) is inclusive and embeds significant investment in interdisciplinary research that brings benefit to patients/citizens and the respective disciplines. We created critical mass by focusing on **four main themes** (Figure 1.4) that interact within and across the three UoA3 schools and across 10 other UoAs, creating a dynamic and innovative research culture. Our research draws upon a large (>6.0 million) socially and ethnically diverse West Midlands population, and engages global collaborations addressing the UN Sustainable Development Goals. We work closely with care providers, commissioners and global policy-makers to facilitate translation of our work into practice. Our themes provide a responsive working culture, concentration of research facilities, sharing of expertise within a highly collaborative environment and create a rich training environment for early career researchers.

The research activities characterising the groups (Figure 1.4) include:

**1.3.1 Dentistry:** Research in Dentistry aims to develop and promote excellence in basic and clinical science to benefit oral and general health. It has re-focused since REF2014 with a clear translational pipeline, emerging from our basic discovery science, delivered through strong basic-clinical science partnerships and evidenced by 18 patents and our spin-out company 'Oral Health Innovations'. Dentistry leverage funding from a broad portfolio including UKRI, national medical charities (e.g. DEBRA), UK government (e.g. MoD), industry and the EU. Research bridges the biological and physical sciences enabling innovation at the interface of several disciplines. The periodontal and clinical trials teams collaborate with the **Institute of Translational Medicine**, exploiting joint medical-dental cohorts in chronic kidney disease, rheumatoid arthritis, and chronic pulmonary disease, in a stratified medicine approach to unravelling disease mechanisms and developing early predictors and diagnostics. Impact was recognised through an NHSE Commissioning Standard on dental health in diabetes (2019) and two active EU grants (RAPiD, TRIGGER) during the REF period. Laboratory and clinical research infrastructure is housed within a purpose built new Dental Hospital/School (opened March 2016, para 3.2), highlighting the sustainability of dental research in Birmingham. In the 2019 QS world rankings, Dentistry rose to 13th, 1st in the UK for citations per output, metrics that are mirrored in SciVal.

**1.3.2 Nursing:** Nursing has one over-arching research theme of **Advancing Nursing Science**. Within this are two programmes: *Risk, Abuse and Violence (RAV)* and *End of Life Care (EoLC)*. RAV focuses on child protection and gender-based violence in particular and has a thriving portfolio of studies, ECRs and PGRs and associate membership from across the University, the NHS and third sector organisations (e.g. NSPCC and Women's Aid). RAV has international reach, impact and significance (e.g. the gender based violence learning resource for healthcare students is actively used across the Universitas21 network). RAV researchers are highly active in the UoB Institute for Global Innovation (REF5a: 2.3). EoLC has been recognised for its partnership working with hospices and the wider EoLC community (e.g. House of Lords launches) and has been instrumental in the design of services to meet patients' needs nationally and internationally (e.g. leading a three country research project to investigate terminal weaning/extubation in ICU).

**1.3.3 Pharmacy:** Research in Pharmacy has one over-arching theme: **Drug Discovery, Delivery and Medicines Optimisation**. Within this are groups focusing on *Medicinal Chemistry, Pharmacology & Drug Discovery; Formulation & Nanopharmaceutics* and *Therapeutic Optimisation*. Research is highly collaborative and interdisciplinary with strong partnerships with the Schools of Chemistry, Biosciences and Chemical Engineering, multiple institutes within CMDS, and NHS clinicians, providing a broad knowledge base enabling translational outputs, exemplified by our spinout company Celentyx Ltd (section 4.4) and the recent recognition of our initiative on drug allergy and intolerance as a World Health Organization Centre of Excellence. Pharmacy's research portfolio includes both established and emerging research areas that reflect the staffing profile. Established research includes neuropharmacology; hypertension diagnosis and monitoring; optimising prescribing and patient safety through the flagship SCRIPT eLearning programme. Emerging areas include for example smart drug delivery, drug discovery, therapeutic adherence and health management in homeless populations.



**1.4 Collaborative Interdisciplinary Context:** Whilst our three disciplines are different, the collaborative context of our research within the UoA is crucial (Section 4). Our particular shared strength is our research governance, mentorship and career development. Dentistry has a track record in research delivery and impact that has hugely influenced our strategic growth, e.g. oral-systemic disease research has led to a global impact with joint international guidelines between the European Federation of Periodontology and the International Diabetes and World Heart Federations (2019 & 2020). Nursing brings methodological, qualitative and theoretical expertise that has visibly benefited research inquiry across the UoA, particularly through research reviews and grant clinics. Pharmacy has a concentration of ECRs who are supported in their career development, and emerging themes which open new avenues for interdisciplinary research.

Key UoB partnerships provide an important strategic and physical infrastructure and stimulus for research in UoA3 (Section 3.2). Three in particular are crucial for our work: the Institute for Translational Medicine (**ITM**) (REF5a: 4.2.3); the Inflammation Research Facility (**IRF**) and the GCRF/University funded Institute for Global Innovation (**IGI**) (REF5a: 2.3).

**1.5 Research Strategy REF2014:** Our strategy in 2014 (submitting only Dentistry), was to maximise the development and use of our resources and expertise to continue to be world-leading in original and distinctive research areas. We said we would strive to provide a dynamic and vibrant research environment to attract, retain and develop the best researchers for whom we provide world-class infrastructure, resources and training.

Following the Life Sciences Strategic restructure (2015; Figure 1.2), we worked together to build on the REF2014 strategy and develop a new integrated plan (goals outlined in Section 1.7). This expounded our new research vision in UoA3 of '**delivering innovation and excellence through research undertaken at the interface of healthcare disciplines, and translating discovery science to health and social care**'.

The restructure provided a unique opportunity to combine health and social care research from bench-to-bedside, and further into society through expertise in nursing and community pharmacy practices (see collaborative outputs across all three schools). The overriding passion and vision in UoA3 is to undertake high quality innovative research within and across the respective disciplines. Our main achievements have been: **establishing high quality research** within the two newer schools (Nursing, Pharmacy); **building a new Dental School** with state-of-the-art laboratory and clinical trials areas; enhancing our track record and research leadership through **strategic staff replacements** and **appointments** at junior and senior levels, including a 'Birmingham Fellow'; **working together** to exploit opportunities for integration, **collaboration and growth** in career development, **capacity and capability building** and increasingly methodology or theory. For example, we engage as a matter of course in cross-school mentorship, grant clinics and publication scrutiny. Our revised strategic goals have been met as demonstrated below.

Goal	Evidence of Achievement
Recruit senior research staff strategically aligned to existing themes, with a clear vision to lead new areas of investigation.	Key appointments were made to strengthen our research portfolio, e.g. <i>Kebschull</i> , <i>Kroeger</i> (Omics of human diseases).
Recruit and develop high quality ECRs toward a sustained research culture.	Nine ECR appointments were made (e.g. <i>Kuehne</i> , <i>Poveda</i> ). <i>Hirschfeld</i> and <i>Yonel</i> have already secured Academy of Medical Science & NIHR personal Fellowships, respectively. Supportive annual research development reviews (section 2).
Initiate new local, national and international collaborations with world-leading scientists.	In this REF period staff have co-authored over 700 outputs with 550 different institutions across all six continents of the world.
Build capacity in clinical and non-clinical pre- and post-doctoral researcher communities.	Compulsory grant clinics and mock interview panels. Joint ECR/experienced academic staff supervision of PhD students (section 2).



Exploit the synergies of new organisational structures, shared facilities and interdisciplinary working.	Competitive cycle for pump-priming collaborative projects (section 4).
Make the translational potential of our research a reality and ensure it impacts on national and international policy, practice and training.	<p>Section 4.4, some examples include:</p> <ul style="list-style-type: none"> <li>• International Guidelines in: Diabetes/Periodontal Disease; Cardiovascular/Periodontal Disease.</li> <li>• World Classification system for Periodontal Diseases.</li> <li>• Advice to PHE and Minister for Health on dental neglect and fluoridation in children.</li> <li>• NHSE Commissioning Standards in Dental care in people with Diabetes and in Restorative Dentistry.</li> <li>• NHS England guidance on trauma informed care in the perinatal period.</li> <li>• Evidence to All Party Parliamentary Inquiry on harmful practices related to faith and belief.</li> <li>• PHE commissioned report on healthcare issues within homeless populations.</li> <li>• SCRIPT is used by 18/42 UK medical schools and by all HEE Foundations programmes.</li> </ul> <p>We have excellent representation at the Universitas21 Health Sciences Group and a track record of success in multi-country U21 grants to support international collaboration.</p>
Enhance research infrastructure and investigator support mechanisms	Section 3.

**1.6 Future strategic plans** We will continue to build upon our excellent collaborations to sustain and enhance our standing as a leading international university for Dentistry, Nursing and Pharmacy. Our approach is to continue to support our existing research themes, but alongside these develop cross-cutting research themes at the interface of our disciplines, to enrich scope and enhance innovation. Many of our research areas have already secured funding beyond REF2021. Sustaining future research capacity and capability building will be ensured by delivering on the following eight initiatives:

<i>Goal</i>	<i>Example strategic activities</i>
Expanding research intensive undergraduate education to build the future pipeline.	Talent-spotting, research electives.
Partnership and joint appointments with healthcare partners.	Clinical academic appointments.
Securing growing numbers of funding council and charity funded training fellowships.	Target fellowships against those with potential to achieve; formal support scheme.
Providing leadership to the West Midlands pre- and postdoctoral clinical academic capacity building scheme.	Secure growing numbers of funded training fellowships and Doctoral Training Programmes.
Enhancing support for good research conduct.	All staff complete GCP and EDI training.

	Mental Health First Aid awareness training PERCAT (Section 2.4).
Regular focused training.	Delivered through seminars and online platforms, for e.g: grantsmanship, PPI, public engagement.
Expanding open access strategy, beyond mere compliance.	Encouraging effective sharing and management of research data.
Achieving a more diverse and international portfolio of funding, with further growth in our share of competitively awarded NIHR and EU grants whilst sustaining research council, government, charity and industrial funding.	Target setting, regular income reports to Research Committees, annual review and bespoke training (2.3, 2.4).

Our plans continued and adapted during- and post-pandemic. We moved flexibly to new arrangements and developed an emphasis on Covid-19 research. Given the diverse population in Birmingham we developed a particular focus on grant submissions around the impact on BAME populations; and we published research, commentary and editorials about the impact of Covid-19 on a range of phenomena, including domestic violence, child maltreatment, ethnicity, and care home services. We shared data pre-publication from our COVDENT serology/salivology longitudinal study of 1,530 dental team members with the Department of Health and Social Care to inform the strategic planning of dental service provision nationally. Laboratories were quickly back up and running post-first lockdown and weekly timetables ensure all PGRs gain laboratory access they need to study in a Covid-secure environment.

### 1.7 Impact Strategy

Our impact strategy aims to sustain and grow our high levels of impact and involves (i) supporting staff with respect to impact awareness and pathways of development, and (ii) ensuring prominence of impact within grant applications. Our current and future strategy is to focus on benefitting patients and traditionally under-represented communities. All researchers are directed to University support mechanisms prior and subsequent to application to maximise impact and dissemination of findings via the press office and traditional (e.g. BBC1) and contemporary (e.g. YouTube) media channels. We have a dedicated impact team in Professional Services to help maximise impact, working with academic impact leads in each school, ensuring 10 year visions for individual programmes and impact tracking through the PURE data information system.

This approach is exemplified by three of our current impact cases benefitting from the support of University of Birmingham Enterprise (1.2.1) [Oral Health Innovations (*Chapple*); SCRIPT (*Marriott, Pontefract*); Celentyx (*Barnes*)] and a further case (periodontitis-systemic interactions) benefitting from public and policy-maker engagement at national and international levels.

Examples of new and emerging impact include: work with the National Rheumatoid Arthritis Society to engage South Asian patients in disease management ([Apni Jung pages of the National Rheumatoid Arthritis Society](#)) (*Kumar*); work with: disabled women and sexual violence survivors (*Bradbury-Jones and Taylor*); Syrian refugees (*Guo*); homeless patients (*Paudyal*); ethnicity and medication adherence (*Paudyal and Jalal*). We support a range of PGR projects focused on LGBTQ people, the Windrush Generation, and forced migrants. We led an interdisciplinary project

producing guidelines for ethical good practice in gender based violence research in LMICs ([our Engage report is here](#)) with ongoing dialogue with UKRI regarding promotion in UK research.

### 1.8 Towards an Open Research Environment [REF5a: 2.2]

The College has a designated lead to implement key principles of open science, in line with current recommendations from research funders and regulators. The University is a signatory to the **San Francisco Declaration on Research Assessment** (DORA) and will join the **European Open Science Cloud** (EOSC). As such we place emphasis on the primary quality of research content, and use this to inform assessment and recruitment decisions. Researchers in ICS maintain an *ORCID* ID to ensure outputs are easily traceable and linked with their PURE account.

**Open access publications:** Staff upload research papers to the PURE data management system within three months of acceptance with support and reminders provided by ICS administration. University-managed UKRI funds and a University pot support GOLD open access publications and publication in fully open access journals. Publications, particularly pre-prints, are also made available as appropriate through (for e.g.) ResearchGate, MedRxiv.

**Open Data:** We are committed to making our data Findable, Accessible, Interoperable and Reusable (FAIR) and these principles are included in our research data policy. We have dedicated free storage facilities for research data that is archived for 20 years. The University has a strong digital infrastructure and all researchers have 4TB free memory to store research data.

**1.9 Research integrity** is enshrined in **Codes of Practice for Research and Ethics** for all research active staff and follows a national framework for good research conduct and governance [REF5a: 2.2]. In our UoA the **Clinical Research Compliance Team** delivers expert support to researchers involving human participants and is subject to external regulatory standards. The team develop and maintain University-wide standard operating procedures, deliver training programmes to staff, undertake audits of clinical research projects, and our HTA licensed and ethically approved Dental Tissue Research Biobank, and provide expert advice and guidance to researchers. The team ensures that the University's responsibilities under the NHS Research Governance Framework are undertaken effectively and efficiently, and that research has ethical review.

New staff and PGR students complete our Online Research Integrity Training programme supported by face-to-face sessions. We provide staff and students with a supportive environment that promotes a culture of freedom and creativity and conveys the importance of personal and academic integrity. We hold regular 'learning reviews' to understand where 'near misses' could occur. Where potential allegations of breaches of integrity occur, the College has a rigorous process for timely and transparent investigations. We have had no documented breaches over the last five years. Dentistry holds a Human Tissue Authority (HTA) license (no. 12313) and has a Designated Individual on the University's HTA Steering Group. In 2016, the HTA inspected the new Dental School and all applicable HTA standards were deemed "fully met".

## 2. People

**2.1 Overview and recruitment strategy:** In our UoA3 return 21/48 are women and 12/48 BAME. The Institute Executive Committee has 21 members, 10 of whom are female. Since REF2014 we



have made 30.00 FTE academic appoints against 14.0 FTE leavers. During the REF period we received the Athena Swan Silver Award.

Our changing staff profile over the assessment period due to retirement of several senior staff and the establishment of the Schools of Pharmacy (2012) and Nursing (2014) has enabled us to recruit ECRs with the potential to be future international leaders in their field (e.g. *Poologasundarampillai; Kumar; Romero-Canelon*). Our Cat A submitted staff have increased from 15.9 in 2014 to 45.3 in this REF return. This strategic approach has facilitated planning and evolution of our research direction and enabled us to exploit new opportunities for growth (often in collaboration), including new research programmes in: oral cancer with Cancer Sciences, cleft lip and palate with Birmingham Children's Hospital; sexual violence in East Africa with Psychology and NGOs in Nairobi; polypharmacology and periodontal and systemic non-communicable diseases with Medicine; drug repurposing and reformulation. These areas are driven by international needs, and are being further supported and developed by recruitment of key personnel (e.g. *Kebschull, Taylor*). We have also seen internal promotions based on research performance (four to SL, three to Reader, three to Chair).

## 2.2 Staffing strategy

Our philosophy is to develop all staff to their maximum potential whilst enabling them to work flexibly to suit caring and other responsibilities. Our overall staffing profile reflects the strategic recruitment and needs of the Schools in order to strengthen and develop key research areas whilst maintaining the personnel necessary to deliver our educational and NHS service portfolios. Specific measures include:

- Identifying 'rising stars' among our ECRs to whom we provide mentorship and tailored support for fellowship applications (e.g. *Hirschfield [AMS]; Sharma, Yonel [NIHR]*).
- Having a process to review training and career progression needs of all staff on an annual basis and proactively support applicants for promotion with CV reviews and mock interviews.
- Undertaking annual Research Development Reviews (RDRs) for research contracted staff.
- Facilitating networking and interdisciplinary working through regular seminars across Schools.
- Mandatory training on EDI for selection panels.
- Appointed an Institute EDI and career development lead and internal EDI champions, who ensure that issues are addressed and policies implemented.
- Staff are encouraged to apply for EDI awards (e.g. *Kumar, Mary Seacole Award*).
- Maintaining a balance between senior staff and ECRs, and basic and clinical scientists, preparing our next generation of research leaders and teams.
- Effective research support mechanisms and mentoring for ECRs.
- A focus on key clinical challenges and questions in order to drive relevant research in health and social care. For example:
  - developing novel photomodulatory approaches to wound healing
  - developing intelligent biomaterials for the delivery of regenerative medicine
  - the increased international focus on domestic violence.
- Regular equality impact assessments are undertaken across appointments to ensure we target under-represented groups.
- A focus on recruiting research fellows on external grant funding.

Our staffing strategy aims to maintain a vibrant mix of clinical and methodological researchers at different career stages, facilitating close interactions that are instrumental for achieving our

strategic aims. We have proactively enabled these interactions through initiatives such as the Birmingham Fellows Scheme (REF5a: 3.4.1) and our external recruitment strategy. We offer mid-career and professorial staff incentives (band increases, additional payments, retention packages) to develop and retain our best researchers.

### 2.3 Staff development

There is strong support for academic promotions including ongoing career development, CV review, advice from senior academics, and practice interviews where relevant. Our research culture, combined with career development support, aims to increase the likelihood that promotions, rewards and progression are equitable and transparent. This approach also aims to ensure retention of key staff aligned to our future research aspirations.

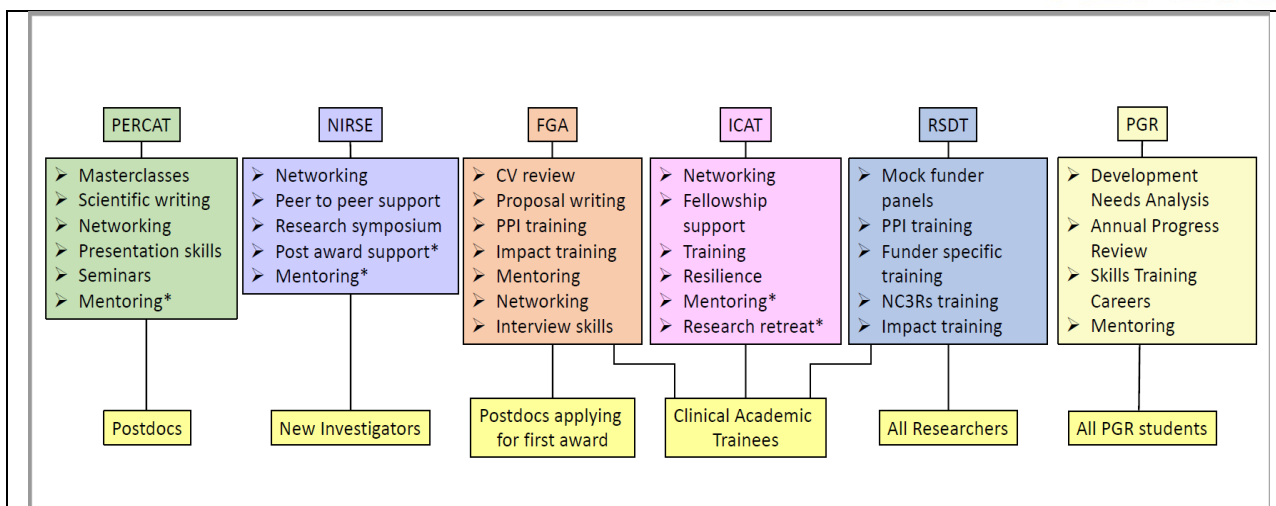
Integration of new, especially international, staff members is actively supported by specifically tailored induction, regular meetings and follow-up support. An internal staff 'buddying system' has been introduced which provides local support in relation to working life at UoB, and practical matters such as help with accommodation and social activity. A comprehensive face-to-face induction process and checklist has been developed. We offer a 3-month check-in process to the line manager of new staff to ensure all aspects of induction have been supported to completion.

The professional development review (PDR) provides an opportunity for individuals to have a structured, constructive conversation about their performance and development needs, to agree stretching (but achievable) objectives for the review period to ensure their development. Additionally, staff who have reached the top of their grade are actively flagged to line managers to discuss opportunities for career progression, such as re-grading or promotion. As a consequence since 2014 13 staff put forward applications for promotion of which 10 were successful (6 women). Achieving research impact and encouraging exchanges with business, industry or third sector bodies are important areas covered in PDRs, alongside our research-focussed annual RDRs.

Our dynamic and popular weekly seminar series includes internal and high-profile external speakers and considers speaker gender balance to ensure visibility of role models. Examples include the alumni lecture series in dentistry and the drug discovery series in Pharmacy. Research groups have implemented successful monthly meetings as informal open sessions to network and share research ideas on their research activity with colleagues. Programme timings are changed at intervals to ensure all staff can attend.

### 2.4 Support for ECRs

We are fully committed to developing our research staff, through the principles of the **Concordat to Support the Career Development of Researchers**, with a comprehensive system of support both at ICS and College level:



**Fig 2.1. Overview of early-mid career development support structures within CMDS supporting UoA3**

**Post-doctoral/ECR development And Training (PERCAT)** provides a wide variety of training and support opportunities for ECRs, driven by their active involvement, providing an ideal opportunity for UoA3 postdoctoral staff to integrate with peers from UoAs 1 and 2. The latest biannual Vitae survey provided evidence of positive ECR engagement within UoA3. Dedicated professional careers advice is provided via bespoke PGR career advisory and PERCAT-coordinated external consultants. *Hadis* (Lecturer in Biomaterials), *Sharma, Yonel, Hirschfeld, Batt, Virdee* (Clinical Lecturer's in Restorative Dentistry) provide excellent examples of ECRs developed via PERCAT training.

**Fellowship and Grants Academy (FGA)** initiative is open to all taking their first steps towards academic independence, offering tailored training, interview skills training and mock interview panels in support of fellows shortlisted for interview. Two female successes benefitted from this in the past year (*Yonel, Hirschfeld*).

Since inception our **Integrated Academic Training Programme** MDS has been awarded 155 NIHR ACF posts and 73 NIHR ACLs, with increasing successes within ICS. Birmingham is in the top 25% of institutions for NIHR-funded training posts. This initiative has supported 5 ACLs and 11 ACFs in Dentistry, three Research Fellows in Nursing and a further five fellowships in ICS in the current REF period, through a portfolio of training programmes. All trainees are provided with a consumables budget additional to NIHR support.

Development of individuals seeking a **combined clinical and research career** is a priority. Most staff have honorary contracts or clinical passports with local Trusts to ensure evidence is derived from and feeds back to clinical practice. The ICAT hub provides intern, pre and post-doctoral programmes, the Midlands Hub for the NIHR 70@70 Nurse/Midwife Research Leaders Programme and hosts the HEE/NIHR Mentorship Scheme for non-medical clinical academics. *Taylor* and *Topping* hold joint NHS contracts and funding, providing strategic research leadership for non-medical clinical academics in their respective organisations. Clinical researchers (e.g. *Sharma, Chapple, Dietrich*) run trials to translate their discovery science into new care pathways, working with funding from the EU, NIHR and national charities (e.g. DEBRA) as well as with Industry (e.g. Unilever, GSK, Philips). ICS currently (co-) supports a number of NIHR training

fellows (3 doctoral, 2 pre-doctoral) and Midlands ARC supported postgraduate students (n=2). *Pontefract* recently gained a Birmingham Health Partner Fellowship. We have an excellent record of hosting medical and non-medical doctoral fellows within our training environment.

The University's unique **Research Leaders Programme** (REF5b:3.4.4) provides training and experience for more senior members of staff and aims to develop world leading research leaders of the future. The prestigious programme has already benefitted several staff in UoA3 (*Bradbury-Jones; Hewison; Palin*) through its intensive workshops and provided further international collaboration opportunities due to extended research visits and ongoing collaborations with institutions in Australia, China, US and Europe. We also actively promote the Aurora Leadership programme for women in Higher Education, with 9 women across all three Schools benefiting since 2014.

We support sabbaticals at international centres of excellence for ECRs (e.g. *Ling* to Harvard) during their training. This enables us to develop research leaders of the future and attract those from collaborating centres (e.g. *Kebschill, Kroeger & Hirschfeld* from Bonn). In order to strengthen staff engagement with University and global priorities, champions have been identified from our leading academics to support staff in identifying partnerships and funding opportunities in European networking, industry engagement and international relations (e.g. *Chapple*).

In recognition of the stresses that ECRs may experience, each School has academic wellbeing champions and support from trained Mental Health First Aiders. Career development of all academic staff is supported by annual PDR, mentorship schemes, leadership development, coaching and courses offered by the University's "People and Organisational Development".

Staff are encouraged to participate in a broad range of symposia and conferences nationally and internationally, supported by ICS travel funds from which 30% of T&R academics have benefited since 2015. All staff are encouraged to engage in active membership of their principal society and to participate in other relevant organisations and learned bodies [Section 4].

**2.5 Postgraduate Researchers (PGRs)** are key members of our research teams and the broader research environment and our aim is to attract, develop and retain the best PGRs. Scholarship schemes also form an important part of our doctoral student-funding portfolio with CMDS, ICS and Schools hosting a number of studentships co-funded by the University with the MRC (e.g. White, Roberts) with funded iCASE awards from BBSRC (GSK) and EPSRC (DSTL, Philips). Our experiences with iCASE awards have highlighted its merit in providing students with exposure to industry and commercial influences on R&D as well as opportunities for generating new technologies as evidenced by patent filing (Section 1.9).

Our collaborative links (Section 4) include cross-College co-supervision of several doctoral studentships (e.g. periodontitis with systemic inflammatory diseases; child protection and culture; sexual violence in Kenya; drug allergy and intolerance, nanopharmaceuticals) and joint publications (e.g. periodontal disease with rheumatoid arthritis/renal disease/COPD/ageing). Our cross-university collaborations include numerous joint PhD studentships (five with Nursing and the College of Social Sciences, seven with the College of Life and Environmental Sciences, five with Applied Health, and several cross-College interactions with doctoral training centres between Dentistry, Pharmacy, Computer Sciences and Chemical Engineering).

We also have a vibrant overseas cohort of PhD students who are fully supported across UoB in terms of their cultural and learning integration. In this REF period 70.83 PGRs have successfully completed their degree. UoA3 currently has 146 PGRs enrolled in the three schools [96 PhD, 50 MRes or MSc by Research], a number that has grown year on year in the period.

We are committed to fairness and inclusivity. Our diversity is a highly valued asset and a key strength underpinning the exchange of ideas, innovation and debate, helping to facilitate a thriving global health research environment. We enrol each PGR on merit and provide flexibility to accommodate their wider needs, including reasonable adjustment plans to support disabilities and responsibilities. Their circumstances can change during the 2-8 years they might be registered with us and we support (appropriate) changes to registration including parental leave, extensions and programme transfers. To illustrate we have produced five PGR babies in the last three years.

We encourage a strong community spirit for our doctoral students with provision of dedicated group study rooms and IT facilities, doctoral student representation on the Graduate School Committee and a range of social/team/network building activities, inclusive of both staff and students. A regular seminar programme facilitates presentation skills training and discussion of students research with exposure to other research areas. We provide training sessions on a range of research skills (e.g. public engagement with science and research, writing for publication), and summer schools, delivered by internal senior academics and external speakers (e.g. BDJ Editor-in-chief, industry collaborators). Students are encouraged to join professional societies and we support them with applying for funding for conference travel, collaborative visits and fellowships. We initiated a Distinguished Lecturer series in 2017 through the Graduate School and welcomed world class speakers such as Dame Mandy Fisher, the Rt Honourable Jacqui Smith and Professor Sir Marc Feldman.

### **2.5.1 PGR Wellbeing**

In the 2019 Postgraduate Research Experience Survey, 83% of ICS PGRs were satisfied with their research degree experience (sector average 81%). PGR satisfaction with supervision, research culture, progression, responsibilities, research skills and professional development exceeded sector averages. 63% reported having a good work-life balance and 82% good mental health.

The College wellbeing team run monthly drop-in clinics. In partnership with Forward Thinking Birmingham and the Children's Society, UoB has established the Pause Drop-In Centre for anyone experiencing mental health problems and requiring confidential support and signposting. We have embedded Mental Health First Aid Awareness in our training for PGR supervisors.

### **2.5.2 Monitoring and Review**

All PGRs have 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 new and established academics) assures quality of supervision and includes EDI training.

The PGR application and monitoring systems moved to online platforms. This transition has helped reduce application processing time, support auditable reporting of PGR progress and rapid identification of issues facilitating earlier intervention.



Full time PGRs meet formally with their supervisors monthly (part time students pro rata) and document their progress, future objectives and any issues via an online graduate report system (GRS-2). Ad hoc supervisory support is available outside of the formal monitoring processes. Each year, PGRs are expected to undertake a development needs analysis using the Vitae UK Research Development Framework to identify knowledge gaps and inform future training plans. This task forms part of their annual performance review. Any student encountering difficulty is supported via regular review by PGR committee members to actively remedy problems.

### 2.5.3 Careers support

Our UoB Careers Centre offers a range of skills and training designed for PGRs looking to find their niche in the jobs market. There are practical opportunities to gain an understanding of business and develop entrepreneurial flair at our University Enterprise Summer School; opportunities to undertake outreach activity; school visits, shadowing and co-developing activities and presentations; talking to media; social media awareness and patient and public engagement training platforms. PGRs also have access to varied seminar programmes, research festivals and away days and a dedicated range of generic and tailored training to equip them to successfully undertake their research and enhance their personal development. Our PGRs are an integral part of these and report real benefit from the support.

Notable PGR successes during the current REF period include first author publications in leading health and social care journals including *Lancet Psychiatry* ([doi: 10.1016/S2215-0366\(19\)30369-4](https://doi.org/10.1016/S2215-0366(19)30369-4)); *Trauma, Violence and Abuse* ([doi: 10.1177/1524838017726425](https://doi.org/10.1177/1524838017726425)); *J Pharmacol Exp Ther* ([doi: 10.1124/jpet.119.261008](https://doi.org/10.1124/jpet.119.261008)), *Chemical Communications* ([doi.org/10.1039/C9CC01057B](https://doi.org/10.1039/C9CC01057B)), *Nature Reviews Disease Primers* ([doi.org/10.1038/s41572-020-0210-0](https://doi.org/10.1038/s41572-020-0210-0)), setting our global research agenda for the next few years.

During the REF period, our students' research excellence was reflected in winning 16 national and international prizes, awards and fellowships, e.g. *Hirschfield*, Academy of Medical Sciences Fellowship Award; Roberts, Highlighted Trainee Author *J Pharm & Exp Therapy*; Williams, Best Poster, Association of Early Pregnancy Units.

The majority of our students progress to pursue careers in science and research (e.g. in academia, *Sharma*, clinical lecturer, *Isham*, research fellow; *Ling* in healthcare industry; *White* in scientific publishing; *Elanheid* in clinical trials).

### 2.6 Equality and Diversity

ICS has a proactive EDI culture whereby individuals are valued regardless of age, disability, gender identity, marital or civil partnership status, pregnancy or paternity/maternity status, race, religion or belief and/or sexual orientation. This is integral to our vision, is embedded within our working practice, and championed by the Institute Career Development and Equality Lead (Coney) to ensure a fair and accessible environment. The EDI lead provides a confidential contact point for advice on EDI-related matters, and represents the Institute on the College EDI Committee which includes representatives from Professional Services and EDI-related University networks such as the Parents and Carers Network, BAME Network, Rainbow and Women's Networks. EDI training is mandatory for all staff. Staff involved in recruitment and promotions panels undergo additional mandatory unconscious bias training. ICS has adopted a scheme run by the BAME staff network which trains volunteers who wish to participate in the University's Interview Panel Register aimed at increasing the diversity of shortlisting and interview panels.

The ex-Deputy PVC for Equalities (*Martin*) chairs the Women in Medicine group which advises women about promotions; offers support where funding for maternity leave is complex; and provides women with pre-promotion interview experience. *Martin's* term as Deputy PVC ended in 2019 when she was appointed Dean of the Medical School in CMDS - the first female Dean in 100 years of training doctors in Birmingham. Hill became the first ever female Head of the School of Dentistry in its 140 year history in 2020.

There is active promotion of the academic and parenting network to raise awareness of assistance to staff with childcare costs, coupled with flexible working arrangements for staff with care responsibilities across the age spectrum (e.g. *Bailey, Batt, Tandy*). There is clear support for maternity, paternity and adoption leave, with gender-neutral amalgamated policies for all three, recognising the importance of co-parenting and differing routes to parenthood. Members of staff with a disclosed disability are supported in ensuring reasonable adjustments are made to ensure equality in the workplace. As soon as UoB moved to restricted operations due to Covid-19 an immediate and supportive University directive went to all staff to confirm full pay, including those who could not continue to work normally, reducing stress levels significantly for those who found 'new' roles as full-time employees, teachers and parents. The LGBTQ+ network is very active in CMDS with staff across all grades as visible role models. We were successful in our application to the Race Equality Charter in 2020 (REF5b: 3.4.5) and are seeking Stonewall accreditation.

**2.6.1 Output and Impact Case Selection:** In preparation for the UoA3 submission, reading panels were gender balanced and we undertook calibration exercises across disciplines to check for unconscious bias. We followed the Code of Practice on output selection, including EDI training for all members of UoA and College panels. We conducted Equality Impact Assessments on output selection data at various stages to check that our process did not appear to be disadvantaging any groups of staff with protected characteristics. At the CMDS REF Board we verified that diversity for UoA3 was balanced. We evaluated 'significant responsibility for research' for ECRs undertaking clinical training pathways. As a result five Dental staff were deemed not eligible for submission, but two held concurrent personal fellowships and a further two were not engaged on clinical training programmes and were therefore included in our return.

**2.7 Staff Wellbeing** is taken extremely seriously with two Wellbeing champions with close links to the wider University Wellbeing services. The leafy University campus provides an ideal environment to promote activities such as working walks, regularly utilised by UoA3 staff as they move between buildings. Many staff take advantage of the University's new £55M Sports Centre, including gym, swimming pool and variety of active lifestyle classes. ICS provides bike racks and showers to support cycling and walking to work. We actively promote and support the annual CMDS Wellbeing week. We have created a privacy pod in CMDS in response to staff experience following return from maternity leave. The pod is a discrete multipurpose room that allows nursing mothers to express milk, and also serves as a prayer room or space for quiet reflection and rest.

### **3. Income, infrastructure and facilities**

ICS staff occupy three buildings, with Nursing and some Pharmacy staff located in the Medical School, the Pharmacy block is a five minute walk and at the other side of the campus, the modern Dental Hospital is a brisk 15 minute walk. The Medical School is a few minutes walk from two large

NHS Hospitals Trusts and the University train station, allowing close collaboration with colleagues across all UoAs and with clinical partners.

### 3.1 Income £16,081,438.00 over the assessment period

We have taken a proactive and considered approach to the development of a growing funding portfolio across our themes., e.g. discussions with UK industry to develop collaborative approaches to CASE Awards resulting in several with GSK and Philips. We aim to deliver a balanced funding portfolio, from a variety of schemes and funders including NIHR, UKRI, industry and Charities. Our RK&T team are pivotal in highlighting relevant calls matched to expertise and supporting bid development, including a specialist EU team (3.6). Our research income during the REF period is provided by a broad portfolio of funders including RCUK [£3m], EU [£2.1m], Government [£5m], charities [£1.8m] and industry [£3.7m] and demonstrates our strategic responsiveness to opportunities and initiatives. In the current REF period we have had significant funding from NIHR [£1.7m], EPSRC [1.7m] and UK industry [£2.2m]. Our trajectory was temporarily impacted by the formation of the new Institute, the move to the new Dental School and Covid-19, but we have exceeded target in a difficult year, providing evidence that our strategy is working.

Recently awarded/newly started grants will contribute to sustainability, including an award from the College of Policing (£666K vulnerable victims) and £800K NIHR (sexual abuse survivors).

We have been extremely successful in applications for beamline time at the world leading Diamond Light facility at Harwell, associated with EPSRC funded research. This has provided £2.29m fully costed research support from this facility (*Poologasundarampillai, Landini, Sammons, Addison, Shelton*). Other **benefits in kind** include the Central Laser Facility to continue our quest of imaging *C. difficile* spores and in particular trying to elucidate their germination receptor (£32K), and £30K through the EPSRC Equipment Loan system.

### 3.2 Infrastructure and facilities

Our strategy is to ensure we have in-house facilities that are used to full capacity and capable of supporting world-class research. We share or collaboratively access facilities/equipment used less frequently or which are of high cost (e.g. we have access to mass spectrometry, MiSeq next generation sequencer and we hire out our Micro-CT campus-wide). This fits well with our research strategy in building strong collaborations that extend scope, multi-disciplinarity and reach for our research programmes (Section 1). We continue to develop state-of-the-art clinical and laboratory research facilities and our new Dental School/Hospital is designed with purpose-built facilities for research programmes with a translational focus. The laboratories and clinical research infrastructure is housed within a state-of-the-art £50M new Dental School, the first in the UK for over 40 years. World class clinical areas (914m<sup>2</sup>) provide two clinical trials suites, an HTA licensed (no: 12312) biorepository and 685m<sup>2</sup> of state-of-the-art laboratory space valued at £1.5M. There is enormous multidisciplinary capacity (e.g. cell, micro and molecular biology, tissue engineering) and there has been significant improvement in quality (e.g. computer clusters, library) and capacity (1860m<sup>2</sup>) for PGRs.

Pharmacy is housed within a central laboratory for dedicated pharmaceuticals research and includes space within Chemistry for drug discovery science. PGRs have a new write-up room and recently refurbished laboratories to create fully equipped facilities dedicated to cell culture. Recent

strategic investment in capital equipment (e.g. £0.9M NIHR RCF funding) keeps us at the cutting-edge of research capabilities, with recent new equipment acquisitions supporting the development of innovative delivery systems and their pharmacological evaluation; imaging (e.g. confocal microscopy), calorimetry for biomaterials science and useful for both Dentistry and Pharmacy; pharmaceutical manufacture (tablet press, coater, granulator) and cell/molecular biology (e.g. £80K Illumina DNA sequencer). These facilities are complemented institutionally by the CMDS Technology Hub with its extensive range of state-of-the-art medical research equipment e.g. Birmingham Advanced Light Microscopy (Batt), other University central service facilities, e.g. mass spectrometry (*Grant*), the development of cutting-edge bioinformatics (e.g. Balacco in Dentistry), the Human Biomaterials Resource Centre and a central asset register for facilities/equipment available within the University. We also benefit from access to equipment at other institutions – e.g. Synchrotron beam time (Oxford, Grenoble, Chicago – *Addison, Landini, Poologasundarampillai*), and the EPSRC equipment loan scheme (*Walmsley*). Nursing PGRs are provided with a large recently refurbished write-up room (80m<sup>2</sup>) with plans for expansion as numbers grow.

**3.3 Clinical research** is enhanced due to our co-location in Birmingham Dental Hospital and the proximity to the new Queen Elizabeth Hospital, Birmingham Women's and Children's Hospitals, Community Trusts, hospices and care homes. Access to a mixed and diverse population and excellent clinical facilities are also important. *Martin* leads the hypertension service at University Hospitals Birmingham, researching pharmacological interactions and patient monitoring. Our joint appointments with Birmingham Women's and Children's NHS Foundation Trust and University Hospitals Birmingham enable close working in applied health subjects and access to NHS libraries, office and meeting space. We are also embedded within the £10M Inflammation Research Facility (IRF) and the ITM at Queen Elizabeth Hospital for research exploring links between periodontal and systemic diseases (underpinning our NIHR ACF/ACL research). The IRF houses six clinics where patient cohorts from five different specialties are collaboratively studied, and provides resources for disease specific assessment. Excellent infrastructure for the conduct of clinical trials exists within the ITM and the Dental Hospital, with support provided by Birmingham Clinical Trials Unit (amongst the largest such provision in Europe), bringing expertise from across the University and three large, well-established, UKCRC fully-registered CTUs. All research benefits from early advice through the regional NIHR West Midlands Research Design Service.

**3.4 Infrastructure for impact** A significant proportion of our infrastructure, facilities and expertise focus on delivering impact. This enables us to drive a joined-up approach across stakeholders such as the NHS, industry, policymakers and most importantly our patients and communities. A key example is the **Institute of Translational Medicine (ITM)**, established in 2016 as a £24m research facility that acts as a central hub for interaction between basic scientists, academic clinicians, clinical informatics, biostatisticians, bioengineers and trial design experts (3.3), to accelerate the development of drugs and devices.

Our collaboration with **Birmingham Community Healthcare Trust** in 2017 increased NIHR portfolio accruals by 542% and ranked first of Community Trusts nationally and first from 15 Local Clinical Research Networks for Oral and Dental Research Portfolio accruals.

**For industry**, we have established a number of CMDS facilities supporting potential UoA3 impact: **BioHub Birmingham** is a £9m bioincubator opened in 2015 to house and support diagnostic spin-outs from the University and across the region. Spin-out companies such as Celentyx have used

this space to build their service offerings and access international markets. **Birmingham Health Innovation Campus** will establish unique innovation facilities and high-quality commercial growth space (REF5a: 4.2.2) that will give us access to Small to Medium-sized Enterprises with competence in areas synergistic to our basic-clinical translational work.

**For policy**, a dedicated Public Affairs team facilitates significant interactions at regional and national levels with MPs, ministers and government bodies. We have hosted a range of government delegations during the current REF period, including Jeremy Hunt and Baroness Blackwood. We are one of only four UK sites to have official MoUs with the Associations of British Pharmaceutical Industries and British Healthcare Industries.

Our **Alumni** and friends' response to our Covid-19 emergency appeal means philanthropy has enabled research into the incidence of and risk factors for Covid-19 amongst dental care practitioners and staff.

### 3.5 Infrastructure for public and patients (PPI)

We have an embedded network of UoA3 public engagement champions, supported by a central team who contributed to the receipt of an NCCPE Silver Watermark Award in 2018. The activities and their outputs have been used locally, nationally and internationally, e.g. the Oxford Museum of the History of Science and the Science Center in Philadelphia (USA); consultations on the future of detecting disease in non-medical settings have explored the public acceptability of this work in England and Scotland; engagement with children and young adults in local museums and science centres (ThinkTank) and through the West Midlands Clinical Research Network Young Persons' Steering Group. We have a 'nurse in residence' (Nicol) at UoB's Barber Institute for Fine Arts, linking artefacts with end of life care research with the public. On-campus events (e.g. Green Heart Festival), have helped shape new research for which published evaluation (e.g. *Yonel et al BMC Public Health*; *Grant et al 2018, Research for All, 2:122–130*, following primetime BBC1 documentary on periodontal-systemic health) is at the heart of the public engagement strategy. We also had a Channel 4 New Year Special (Jan 2020), 'Food Unwrapped'. The 'Open Wide Public Engagement Project' (curated by *Grant*) exhibits art-science collaborations on research in the Dental School and has a permanent location in the foyer of Birmingham Dental Hospital, which has a footfall of 120,000 patients per year. Additionally Open Wide attracts visitors for specific exhibitions, through local and national advertising. With each exhibition a participatory workshop is held to enable dialogue between researchers and patients and visitors to the Dental Hospital and directly with school children and home-schooled children outside of the Dental Hospital ([bdhopenwide.com](http://bdhopenwide.com)).

We have developed deeply engaged forms of PPI, specifically in the field of co-produced research. Funded studies (e.g. NIHR HS&DR 18/02/27) have employed lay members as co-researchers, demonstrating strong commitment to participation in research. Acknowledging that a significant amount of research is conducted in a broader context than health facilities, there are numerous examples of Community Engagement and Involvement (CEI), which expands concepts of engagement to take account of communities. This is particularly apparent in projects funded through the **IGI** in Low and Middle Income Countries, including a co-developed film on albinism [See My Life](#). We have close partnerships with local hospices, charities and Birmingham City Council, reflected in joint grant applications (e.g. *Bradbury-Jones et al, NIHR sexual abuse survivors*) and representation on relevant committees (section 4).



### 3.6 Operational and scholarly support structures

The CMDS Strategic Research Committee (SRC) brings together research leads, Institute Directors and NHS partners on a monthly basis to discuss collaborative current and emerging opportunities, metrics and challenges. SRC reports to the CMDS Research and Knowledge Transfer Executive, chaired by Head of College, for approval and action, including release of related College-level resources. Equality and diversity are standing agenda items to maintain focus across all protected characteristics.

Research management within the College is based on integrated leadership from Academic and Professional Services which oversees a team of 90 staff that work within grant award and implementation, regulatory compliance, research integrity, translation and training. They work closely with University-level teams covering Business Engagement; Strategic Projects; Charitable Funding; Interdisciplinarity (Institute for Global Innovation, incorporating our Institute for Advanced Studies); Commercialisation (UoB Enterprise); External Relations (including Public Engagement with Research); International Collaboration; and Research Finance. Our team of research technicians (HEFCE, NHS & industry funded) oversee the smooth running of our facilities and contribute significantly to delivery of high quality research. Research innovation, enterprise and knowledge transfer is strategically and operationally supported by Birmingham Enterprise Ltd., with UoA3 staff benefitting through licensing, consultancy contracts, patent filing and development of spinout companies, enhancing our global impact.

To sustain the ambitions of Birmingham 2026 (REF5a: 2.1.4), significant support is provided via the central CMDS **Research Support & Development Team**, dedicated to help investigators to secure relevant career development guidance, submit high quality research proposals including large, collaborative and strategic programmes of academic endeavour, and to ensure robust and efficient research operations such as contractual negotiation, governance and intellectual property management. We have a dedicated ICS Research Facilitator (Williams) providing bespoke pre-award support to UoA3 researchers in preparation of funding applications. The pre-award support team offers one-to-one engagement and guidance in the preparation of winning applications for investment from a vast array of national and international charities, public funder organisations and commercial partners, and works closely with UoB Enterprise to ensure that all our ideas and innovations are identified and protected at an early stage.

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

**Collaboration** is embedded within our research programmes and has significantly extended the scope and interdisciplinarity of our research (of 113 submitted outputs for the period, 48 are denoted interdisciplinary). Joint authorships on publications and co-applications on grants with collaborators highlight the success of our approach as well as many staff having national and international visiting/honorary appointments. Collaborations are at local, national and international levels, e.g:

#### **Locally**

- Working with Birmingham safeguarding teams to analyse child abuse reports during the pandemic (*Taylor*), targeting policy makers regarding school closures, particularly in deprived communities.

#### **Nationally**

- Anti-depressants after psychosis, NIHR HTA £2m (*Barnes*) with Psychology. Part of a wider portfolio of projects focusing on pharmacological interventions in psychosis.
- Office for National Statistics on UK dental health: a national consortium working with ONS to deliver 10-yearly dental health surveys (*Morris, Ravaghi, Hill*).
- 'UltraSurge': £6-million EPSRC-funded consortium [Universities of Birmingham, Glasgow, Edinburgh, Leeds, Southampton] (*Walmsley, Scheven, Shelton*).

### **Internationally**

- 'RAPID': €4.3M EU-funded consortium on periodontitis and rheumatoid arthritis with £680k to UoB (*Dietrich et al*).
- Representation on the U21 Health Sciences Group nursing forum and leading case studies for Sustainable Development Goals (SDG), resulting in joint funding and strategic partnerships across the U21 network (*Bradbury-Jones*).
- SCRIPT, a web-based programme for optimising prescribing safety that has standardised the delivery of education on prescribing and therapeutics across the world (*Marriott et al*).
- Research staff and student exchanges worldwide including Australia, China, India, Brazil, USA.

We nurture basic-clinician science partnerships, which enables our translational pipeline and facilitates key clinical questions to be addressed whilst also facilitating clinician-scientist/researcher development. We will maximise these strengths in our goal for research innovation for patients, healthcare and wellbeing by continuing to target translational funding streams (e.g. Innovate UK, NIHR) and grow our portfolio of international studies. For example, the Phototherapy group within Dentistry has established cross-cutting themes with UHB, Institute of Inflammation and Aging and neurosurgery to develop novel treatments for traumatic brain injury. The collaboration has secured pilot funding from the Midland Neuroscience Teaching & Research Fund (2018-2019) leading to two patent submissions in 2020, which will underpin a multi-million NIHR application to drive translation of this disruptive technology.

### **Category C Staff**

We have three category staff C. Dentistry has 1.5 FTE Research Nurses employed on clinical trials, and in Nursing, Dr DeBelle (paediatrician), has an honorary contract with the RAV team working on child protection.

### **4.1 Industry and the health sector**

We have a demonstrable history and diverse engagement with the wider health and industry sectors that significantly contributes to the economy and society: £6.3M of our income in the assessment period is from the health sector and commerce. Expertise in biomedical materials science and stem cell biology provide opportunities to exploit smart new therapeutic solutions delivered through medical devices and supported by our 26 Industry partnerships. Between 2012-2020, Dentistry filed 18 patents (US, Asia, Europe, UK). Four patents in 2019/20 (US, Europe) related to bone augmentation materials and technology for the treatment of traumatic brain injury. Eleven patents (US, Asia) were with Philips Eindhoven in saliva diagnostics for periodontal diagnosis (two published 2019). Two patents were filed in 2020 (Asia, UK) for bioprinting/monolythic gel synthesis and one UK filing for the development of a bioprobe. Our spinout company 'Oral Health Innovations' has delivered digital risk assessment technology into >850 dental practices (>150,000 patients).

We have captured several iCASE awards (section 2.5) and work with the NIHR Surgical Reconstruction & Microbiology Research Centre with support from the MoD to identify novel light-therapy approaches for wound repair and disinfection in injured military personnel (*Palin, Milward, Kuehne, Hadis, Shelton*). We also have NIHR-funded interdisciplinary collaborations. For example the Photobiomodulation Research Group has worked with industry (Thor Photomedicine) in the development of light therapy-based approach for dental tissue repair.

Several partnerships are long-standing, e.g. Unilever (*Chapple*) and GSK (*Cooper, Milward, Chapple*) >25 years; and have generated new technologies (e.g. medical devices for treating traumatic brain injury, *Palin, Milward, Hadis*). We have a plethora of current strategic industrial research collaborations, including Angelus Dental, Brazil (2019-2021): Alternative Cementitious Components to Hydraulic Calcium Silicate Endodontic Materials; *Camilleri, Tomson* (£327k UoB). Our new Business Engagement teams support new and existing Industry collaborations and have supported us in filing patents.

**4.2 Third Sector collaborations** We have long standing partnerships with **non-governmental organisations** leading to new collaborations in East and Southern Africa, e.g. Source of the Nile Union for Persons with Albinism (*Taylor, Bradbury-Jones*). We have strong links (co-investigators, advisory groups, joint publications) with the Third Sector (e.g. Barnardo's, Women's Aid) and have made leading contributions to the evidence base in working with patients, public and survivors. In RAV we aim to include survivors as co-applicants/researchers in all projects and evidence this in current grants (NIHR, Burdett). In partnership with the National Rheumatoid Arthritis Society we provide tailored support for the UK South Asian population in disease management (*Kumar*). We engage with diverse communities and the public through stakeholder groups and co-research models (Section 3.5).

**4.3 Interdisciplinary translational research** Our research is underpinned by our broad collaborations in multiple areas (e.g. Biology, Engineering, Metallurgy). Its importance is illustrated for e.g. by our studies on brain implants for oncology (*McConville*), dental/orthopaedic materials (*Palin, Shelton, Hofmann*). The diversity of these collaborations has been central to much of our research strategy and the collegiate structure in Birmingham has greatly facilitated this. Our collaborative working has also been promoted through appointment of international honorary visiting Professors (e.g. Ferracane, Oregon; Nor, Michigan). We regularly host visiting international researchers, in the last year alone from Australia, Brazil, India and the USA, resulting in joint publications and grant applications.

We have 40 strong collaborative links with many research groups across the University, including:

In CMDS

- Institutes of Inflammation & Ageing; Immunology & Immunotherapy: links between oral, chronic & systemic inflammation & ageing immune system (*Chapple, Grant, Hirschfield*); novel phototherapy treatments in neurosurgery (*Palin, Milward, Hadis, Davies, Belli*); West Midlands Allergy and Immunology Centre (*Marriott*).
- Institute of Applied Health Research: sexual abuse survivors (*Bradbury-Jones*); ARC Maternity Theme (*Hewison*).
- Institute of Cancer & Genomic Sciences: In oral cancer, *Wiench* is a joint staff appointment with Dentistry and *Landini* works jointly with the Cancer Research UK Centre.

## Unit-level environment template (REF5b)

- Institute of Metabolism and Systems Research, post-partum haemorrhage and miscarriage (*Topping*).

With Colleges outside CMDS

- Life and Environmental Sciences: Geography-led Childhood's Network (*Taylor*), *Ali-Boucetta* with environmental scientists on nanotoxicology, *Barnes* with Psychology on neuropharmacology; Grant and Chapple with Biosciences (biomarker discovery)
- Institute for Crime, Justice and Policing, evaluating police interventions for families with adverse experiences (*Bradbury-Jones, Taylor*).
- Social Science: researching migrant maternity care (*Bradbury-Jones, Taylor*)
- Engineering and Physical Sciences: medicinal chemistry and drug discovery (*Bottegoni, Jones MC., Roper, Jones A., Romero-Canelon*).

Our intra- and inter-university collaborations (demonstrated by publications, grant income, Honorary Chairs and PhD co-supervision) have considerably enhanced our research activity and success in: i) targeting specific research sponsors (e.g. EU, EPSRC, charitable programmes), and ii) attracting joint high-quality appointments (e.g. *Hadis* biomaterial, *Jones, A.* med chem and *Topping*, end-of-life care). and doctoral research students.

**4.4 Beyond the University** Internal funding enables partnerships which are based on University agreements, e.g. Birmingham-Nottingham fund (*Milward, Palin*); Birmingham-Illinois at Urbana-Champaign (*Taylor*). Funding from the **Institute for Advanced Studies** (REF5a: 2.3.1) and the **IGI** provide important seed funds for international collaborations (e.g. *Bradbury-Jones, Taylor*). Staff hold honorary chairs at prestigious research intensive universities including *Barnes*, Melbourne; *Efstathiou*, Ottawa; *Bailey*, Johns Hopkins.

Broader institutional strategies for collaborative international research programmes involving China, USA, Australia and Brazil (REF5b: 2.1.8) complement our existing international collaborations (e.g. overseas research visitors and PhD students). We support a range of overseas attachments (e.g. *Sharma*, Harvard 2018; *Yonel*, Greifswald 2020) which strengthen our research culture. We support staff (e.g. seed funds, sharing networks) in engaging with other researchers, organisations and learned societies at international levels e.g. Professor Wong from UCLA spent a week with cross-campus researchers collaborating on saliva diagnostics.

Our researchers **undertake national and international leadership roles** with involvement at various levels, reflecting career stage. Staff in senior leadership roles contribute to 17 nationally and internationally recognised scientific groups as either President, Chair, Secretary or Treasurer. Most notably: the Secretary General of European Federation of Periodontology (*Chapple* 2017-2019); Chair of the European Academy of Nursing Scientific Committee (*Taylor* 2012-2016); Chair of Multilateral France-Germany-Canada, Epigenomics of Complex Diseases (*Barnes*); Vice Chair Association of Child Protection Professionals (*Taylor* 2014-2019); British Dental Association Scientific Adviser (*Walmsley*); President of ABOMS (*Dietrich* – 2018), President of the British Society of Periodontology (*Chapple* – 2014/15), Chair of globally influential European Federation of Periodontology (EFP) Workshops (*Chapple* - 2008-2020); President of the British and Irish Hypertension Society (*Martin*).

Our staff also contribute to 32 national and international societies, committees and agencies, including: Board Member and Chair of Marshall Postdoctoral Award, Academy of Dental Materials

(*Palin*); Coordinator of the EFP S3-Level Treatment Guidelines (*Kebschull*); Councillor for the International Society of 5-HT research (*Barnes*); PRIMA Québec (*MC Jones*); Grant Commission Member for the European Society of Clinical Pharmacy (*Paudyal*); General Nursing Council (*Topping*), Birmingham and Solihull Women's Aid Trustee (*Bradbury-Jones*); and the National Research Agency (*Romero-Canelon*).

Our researchers also drive **agenda and policy change** by writing national and international guidelines through peer review and standards associations, the most notable of which include NHSE/I Commissioning Standard on oral health and diabetes (*Chapple* co-author); World Classification of periodontal and peri-implant diseases (*Chapple*, co-chair); European treatment guidelines in periodontal care (*Chapple & Kebschull* – co-chairs); Joint medical-dental international guidelines on periodontal care and diabetes with International Diabetes Federation (*Chapple*, co-chair); Joint medical-dental recommendations on periodontal and cardiovascular diseases with World Heart Federation (*Chapple, Dietrich*); the House of Lords Adoption Select Committee (*Taylor*); REF2021 panel member (*Taylor*); Research Grants Council of Hong Kong (*Camilleri*); British Standards Institute and International Standards Organisation for CH/106/1 (Dental Restorative and Orthodontic Materials) and CH/106/2 (Prosthetic Materials) (*Palin*); EPSRC Panels and Reviews (*Poolagasundarampillai, Palin, A Jones, MC Jones, McConville, Romero-Canelon*); the ERC (*Bottegoni*); and the Newton Fund (*A Jones*).

Our strong **business engagement strategy** involves numerous staff who provide expert advice and consultancy to industry, influencing their R&D programmes (evidenced in impact case studies) such as, representation on Advisory Boards of GSK, Unilever, Philips Oral Healthcare, Johnson & Johnson, Mars, Colgate, Attenborough Dental, Septodont, 3M, Ivoclar, Voco, FKG (*Chapple; Walmsley; Tomson; Camilleri, Khambay, Palin*). *Grant* has received £15K from the Arts Council UK to establish a **public engagement** initiative within dentistry (Section 3.5). *Barnes* is the Principal Founder of Celentyx Ltd, a venture capital funded pharmaceutical research and development company focusing on diseases of the immune system and immuno-oncology.

Our research excellence is also evident through senior editorial positions. **Editors-in-Chief include:** Dental Update (*Burke*); European J Prosthodontics and Restorative Dentistry (*Palin*); J Clinical Periodontology Digest (*Chapple*). Many of our staff act as **Associate or Guest Editors of international high impact journals including** J Clinical Periodontology (*Chapple*); Periodontology 2000 (*Chapple*); Frontiers in Immunology (*Kebschull*); MDPI Molecules (guest Editor *A Jones*); Child Abuse Review (*Taylor, Bradbury-Jones*).

Our research contribution towards scientific communication amongst peers is further highlighted with numerous staff that serve 44 **editorial boards of leading journals in their specific fields of expertise including** J Dental Research (*Dietrich,*); Dental Materials (*Palin*); J Clinical Periodontology (*Chapple, Kebschull*); J Dentistry (*Palin, Addison, Walmsley*); Neuropharmacology (*Barnes*); J Advanced Nursing (*Taylor*); Rheumatology (*Kumar*), J Clinical Nursing (*Bradbury-Jones*); Int J of Social Research Methods (*Bradbury-Jones*); and J of Nursing Management (*Hewison*).

Our researchers continue to be recognised at the **highest levels internationally** as reflected in prestigious awards and Fellows of Learned Societies, most notably, Distinguished Scientist in Periodontal Research, International Association of Dental Research (IADR) (*Chapple, 2018*); Sigmund S Socransky Young Investigator Award, IADR (*Kebschull, 2017*); Top 3- IChemE Global



Awards (*Barnes*, 2017); Distinguished Young Investigator Award, IADR (*Addison*, 2016); Lyndsay Memorial Distinguished Lecturer, British Dental Association (BDA) (*Chapple*, 2016); John Tomes Medal, BDA (*Walmsley*, 2016); William J Gies Award, IADR (*Kebschull*, 2015); American Academy of Periodontology special citation award (*Chapple*, 2016); Inaugural fellow British-Irish Hypertension Society (Martin); DCF Prize for Medicinal Chemistry (Italy) (*Bottegoni*); EMFC (Young Medicinal Chemist in Industry) runner-up (*Bottegoni*); Fellow of the Royal College of Nursing (*Taylor*) and Winston Churchill Foundation Fellowship (*Bradbury-Jones*).

The internationally-leading profiles of our researchers have led to numerous **invited keynote lectures** at (inter)national conferences, society meetings and other Universities. For example *Barnes* has been invited to speak about P2x7 receptor antagonism in numerous universities around the world, including Melbourne, Malaysia and Washington. Our discipline leadership is evidenced by our involvement in the scientific organisation of conferences and symposia (e.g. BSODR Birmingham 2021; RCN Birmingham 2018).