

**Institution:** University of Huddersfield

**Unit of Assessment:** UoA5 Biological Sciences

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

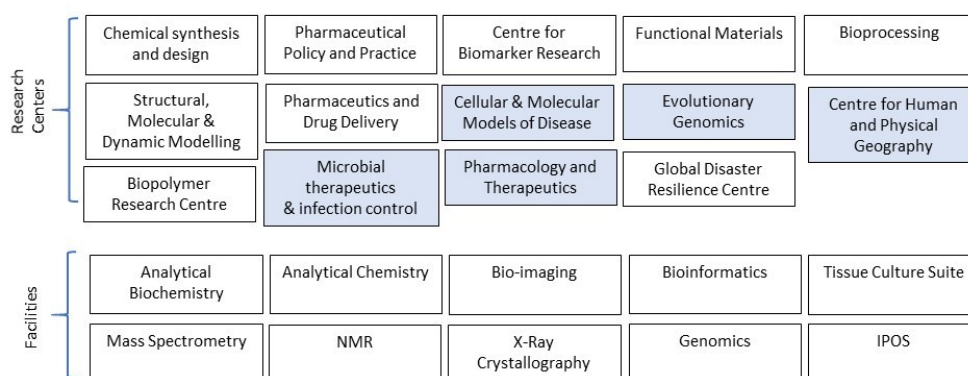
### 1.1 Unit context

Biological Sciences at Huddersfield has grown markedly since 2014, when 13 FTE were submitted in the University's first return to Unit of Assessment 5 (UoA5). For REF2021, 29.8 FTE (30 individuals) are returned to UoA5 with only 6 individuals (6.0 FTE) still in post from 2014; 2 further individuals (2.0 FTE) are returned to UoA4 and UoA8 for REF2021. Our rapid expansion of research activities in biological sciences reflects School of Applied Sciences' commitment to act on the University of Huddersfield's vision to be an inspiring, innovative University of international renown and execution of the research strategy developed in 2014. Our mission and aims are to foster a spirit of (co-)enquiry and partnership for innovation and change in response to key challenges affecting human health, environment, society and informing on past histories at recent or ancient evolutionary scales. We aim to make real differences to society internationally, nationally and locally. External research income has increased 9.9-fold across the unit with 84% of income generated since the start of academic session 2016/17. Further details documenting our progress acting on the 2014 strategy and a new forward-looking unit-specific strategy are outlined in sections 1.4 and 1.5, respectively.

### 1.2 Unit structure

University of Huddersfield's UoA5 is a submission led primarily by the Department of Biological and Geographical Sciences within the School of Applied Sciences (AS). In line with the University's research vision and strategy for excellent research with impact contributing to important advances in human knowledge and significant improvements to global quality of life, our research in UoA5 is both fundamental and applied in its scope. The research coalesces broadly around three themes: (a) cellular and molecular models of disease; (b) evolutionary genomics; and (c) applied environmental microbiology and biology. Individuals and academic teams contribute within the Research Centres highlighted in **Figure 1**. Research critical mass and outputs associated with each theme have increased evenly since 2014: appointments have been made at professorial and early-career levels plus 14 staff have enjoyed promotion since 2014 (detailed in 2.1).

**Figure 1.** Research Centres and Facilities in the School of Applied Sciences



Our research in UoA5 is often **interdisciplinary**, reflecting close integration of four departments within the shared research, teaching and administrative facilities of Joseph Priestley Building. Other departments in AS are Chemical Sciences (including chemical engineering); Pharmacy; and Optometry and Vision Sciences. In taking opportunity to expand our research profile in biological sciences during the last six years, research funding from the University for Areas of Strategic Research Importance (ASRIs) and Global Challenges Research Fund (GCRF) Sandpit Challenges has allowed opportunity for the interdisciplinary strands of our research within UoA5 to grow. Thus, staff from Biological Sciences work closely with research groups in other areas of

AS and with colleagues across the wider university. Success of internal pump-prime activities, combined with external funding are perhaps best illustrated by the development of impact case studies (ICSs) led by Georgopoulos and Hwang: the former builds on activities discussed in the environment statement from REF2014; the latter is delivered by a staff-member appointed only in 2018 through the University's Research Excellence Staff Scheme and supported thereafter from QR and Sandpit funding in the initiation of a new project linking wild coffee biodiversity in Ethiopia with remote sensing and innovative mapping techniques.

Within UoA5, the composition of staff being submitted includes **4** Professors, **5** Readers, **1** Principal Enterprise Fellow, **15** Senior Lecturers, **4** Lecturers (now promoted to SL), and **1** Senior Research Fellow. **2** additional academic staff members of Biological and Geographical Sciences (1 Senior Lecturer; 1 Lecturer) are being submitted to UoA4 and UoA8, respectively, to reflect their research interests. There are **5** academic staff members and **2** research fellows who are classified as either not having significant responsibility for research or are not independent researchers according to the University of Huddersfield's [code of practice](#). In addition, there are several post-doctoral research assistants who also don't formally meet the requirements for inclusion but contribute to the unit's research activity and culture. The increase in independent, research-active staff represents a significant step change in the unit's activities since REF2014 (13 staff submitted) and reflects the broader institutional strategy (2013 – 2018) to strengthen and enhance research capacity across the University.

Within the unit, the Research Centres and Institutes are the 'engines' of research activity, promoting research career development and providing 'research homes' for individuals with common interests, including established researchers (including centre leads), early career researchers (ECRs) and postgraduate research (PGR) students. The establishment of discrete Research Centres throughout this REF cycle does not raise barriers to but rather promotes, collaboration and multi- and inter-disciplinary research – staff and students are able to align themselves with multiple Research Centres. Notably, although some Research Centres align closely with different UoAs, they are not organised along departmental lines. Instead, fluid organisation serves many purposes including the breaking down of barriers that can exist in a departmental structure and promotes communication between scientists with different skill sets. For example, research within the Pharmacology and Therapeutics and Molecular Models of Disease Research Centres typically involves Research Centres not specifically associated with UoA5 (e.g. Chemical Synthesis and Design (UoA8) **Figure 1**) but has resulted in publications in leading multidisciplinary journals such as *Angewandte Chemie*.

### 1.3 Research centre activities: highlights 2014-2020

Our philosophy for the Research Centres works in part because AS staff work together in a single research environment spread across interconnected Joseph Priestley West, South, and East Buildings. Cross-centre collaboration is aided by the fact that specialist facilities within AS established via School or University funding are available to all academic, research staff and PGR students. In addition, research laboratories are open plan, each serving as the base for several research groups. Occupancy of academic offices is 2-3 per office, often by staff from different departments. To look at selected success highlights:

[Evolutionary Genomics Research Centre](#), with its ancient DNA laboratory, has led or participated in research collaborations with scientists from over 30 institutions spread across Europe, North America, and Australia including Harvard, Oxford and Max Planck Institutes. The Centre hosts visiting positions for Hans-Jurgen Bandelt (Hamburg); Antonio Salas (Santiago de Compostela); Antonio Torroni and Alessandro Achilli (Pavia); Pedro Soares (Minho) Jim Wilson (Edinburgh); Stephen Oppenheimer and Peter Ditchfield (Oxford); and Rosalind Hunter-Anderson and Dominic Powlesland (independent archaeologists). The international reach of the Centre is illustrated by Prof **Richards'** recent invitation from the Norwegian Academy of Science to join their annual research symposia. Recent big-data led research outputs from researchers in this centre span forensic archaeology and entomology, archaeogenetics, molecular ecology, and molecular evolution including:

- an 8000-year genomic history from pre-farming to the present of the Iberian Peninsula (**Richards**, Science 363:1230-34)
- plant manipulation and cultivation without domestication during the Holocene 'Green' Sahara (**Vanin** (now Professor of Zoology, University of Genoa), Nature Plants 4:71-81)
- genetic ancestry of the world's first farmers (**Richards**, Nature 536:419-424)
- postglacial admixture of non-human mammal species in Europe (**Edwards**, PNAS 116:17231-17238; Molecular Biology and Evolution 35:1120-1129)
- evolution of virulence traits in neglected pathogens (**Ginger**, Trends in Parasitology 37:100-116)
- influences of codon usage bias, RNA modification, and mobile DNA during early animal pre-history (**Carr**, Molecular Biology and Evolution 35:2499-2511)

[Cellular and Molecular Models of Disease Centre](#) staff have developed or applied experimental models to address key questions in the biology of normal tissues and disease and with inpatient groups including the elderly and children. A group focus is the development of alternatives to animal models in line with principles of reduction, replacement and refinement (the 3Rs); recent activities include molecular insights into:

- Metabolic physiology and addiction-related disease using nematode models (**Kinnunen**, EMBO Molecular Medicine 9:1379-1397; Science Advances 6:3)
- Microfluidic models of tumour environments for drug delivery (**Allison**, Scientific Reports 6:36086)
- potential therapeutic options for rare skin disorders (**Hennies**, Journal of Investigative Dermatology 139:1191-1195)
- Cooling prevention of chemotherapy-induced alopecia (**Georgopoulos**, PLoS One 15:e0240454 and ICS)

[Pharmacology and Therapeutics Centre](#) staff work on development and evaluation of candidate therapeutics designed to target cancer and neurological disorders. Here the range of recent work includes:

- phenotypic evaluation and target deconvolution of novel chemical & targeted intervention against specific biochemical pathways (**Allison**, Science Translational Medicine 10:eaar2718; Cancer Letters 403:98-107; Angewandte Chemie 57:9799-9804 & 59:14677-14685)
- tumour cell migration and tissue invasion and development of three-dimensional cell culture models (**Brüning-Richardson**, Journal of Visual Experiments 151:e60273; Interface Focus 10:20190070)

#### 1.4 Achievement of strategic aims for research and impact from REF2014

In REF2014, University of Huddersfield returned to UoA5 for the first time where research interests encompassed archaeogenetics and evolutionary genetics; biochemistry; molecular and cellular biology; analytical bioscience; and forensic biology. The post-2014 research strategy has built upon existing research strengths whilst broadening the research footprint in alignment with the University's ASRIs and long-term aim of becoming an internationally recognised, research-led institution. Notable in our UoA5 progression over the last 6 years has been establishment, in line with University ASRI 'Health', of new, modern cell and tissue culture and cell-imaging facilities. From almost nil resource and limited personal (only **Georgopoulos** returned to UoA5 in 2014), AS has established key resources summarised in section 3.2 and built a diverse research portfolio, including activities summarised in section 1.3. With 12 of the staff returned to UoA5 for REF2021 (including 9 post-2014 appointments) associated with [Cellular and Molecular Models of Disease](#) and/or [Pharmacology and Therapeutics Centre](#) Centres, work in this area provides a prime

example of delivery on **A1** below. More generally, the post-2014 research strategy for UoA5 is summarised by 4 key aims:

**(A1)** Establishment of coherent research groupings, expanding in areas with existing expertise and provision of new, high-quality research activities

**(A2)** Development of high-profile multi- and inter-disciplinary research

**(A3)** To generate income from external funding sources to support substantive research

**(A4)** To generate high quality outputs from existing and new staff.

In addition to a strategic shift towards molecular medicine ([Cellular and Molecular Models of Disease](#); [Pharmacology and Therapeutics](#)), other areas through which **A1** was addressed included transition from an archaeogenetics-led Evolutionary Genetics Group to an [Evolutionary Genomics Research Centre](#). In part, the evolutionary ratchet from 'genetics' to 'genomics' reflects the enormous amounts of data now readily generated at population levels from next-generation sequencing. However, the remit of the Evolutionary Genomics Centre also captures fully our expertise and international reputation in the area of archaeogenetics, whilst reflecting a diversification of interests following new staff arrivals, combined with the application of transcriptome and whole genome next-generation sequencing approaches in the group's work.

A major strategic expansion and investment (**A1**) within UoA5, unplanned at the census date for REF2014, was undertaken in 2018-2019: the development of research at the interfaces between environment, biology and physical geography. Newly appointed staff have been successful in generating external research support from NERC and ESRC for research relating to remote sensing, freshwater ecology, geomorphology and biodiversity. This investment in new staff appointments and resource coincided with development of new BSc undergraduate teaching programmes in geography and (in its broadest sense), the latter thereby complementing AS' existing BSc options in biomedicine, medical genetics and biochemistry. Looking forwards, in section 1.5, we outline how building on this nascent research, which is already delivering outputs and research income, is a key strategic goal for the next REF cycle.

Our development of new research themes and groups has focused heavily on developing interdisciplinary research (**A2**). To exemplify this interdisciplinary focus, the establishment of the Institute for Skin Integrity and Infection Prevention in 2015 (**A1 and A2**) provided significant opportunities for staff within UoA5 to work across the University. **Humphreys** and **Georgopoulos** are members of the Institute's management board plus **Georgopoulos** and **Hennies** have established skin-related research profiles. In the area of applied biology, more recent collaboration, between members of the Centres for **Human and Physical Geography** and **Sustainability, Responsibility, Governance and Ethics** in UoA17 (**A2**) have successfully applied remote sensing to the management of wild coffee in Ethiopia leading to one of the ICS returned for UoA5.

With regards to (**A3**), cumulative income for UoA5 has grown by almost an order of magnitude since REF 2014: from £318,362 (in 2014) to £3,167,014 (by Dec 2021). Notable awards in the current REF cycle were £1,050,000 from the Leverhulme Trust (match-funded by AS and the University to £1,878,617; awarded to **Richards** in 2015) for 'Genetic Journeys into History: the Next Generation', a DTC in archaeogenetics; €308,000 within an inter-disciplinary ERC archaeology and archaeogenetics project studying the settlement of New Guinea and Australia; and £500,000 from Paxman Coolers Limited (match-funded to £1,000,000; awarded to **Georgopoulos** and **Collett** in 2019).

Our aim to increase the number of high-quality outputs from existing and new staff (**A4**) aligns with Institutional strategic aims (UoH Strategy Map 2013-2018 and 2018-2025). Since 2014, our staff, during the current REF cycle, have produced 472 research outputs (with 5992 citations at an average of 12.7 citations per publication), including publications with a University of Huddersfield



address in journals such as Nature, Science, PNAS, Nature Plants, Nature Communications, Science Advances, Science Translational Medicine, EMBO Molecular Medicine, Angewandte Chemie, Chemical Science, Molecular Biology and Evolution, BMC Biology, and Biological Conservation. In summary, information presented above demonstrates that we have achieved, and in many cases, exceeded stated aims of our research strategy as articulated in REF2014.

As described in the Institutional Environment Statement, the University's Research Strategy commits to delivering excellent research with impact providing direct economic and societal benefit for the communities we support. The post-2014 UoA5 impact strategy aimed to harness the interdisciplinary nature of our research to secure improvements in health, society, environment and society. This strategy can be illustrated through the following impact elements **(E)**:

**(E1)** Continue to foster an impact focus

**(E2)** Maximise effectiveness of our collaborative network and further develop relationships

**(E3)** Effectively communicate our research to the public

**(E4)** Recognise and reward staff excellence.

We embedded impact training for all staff through School research away days, expert-led workshops and events run by Research and Enterprise **(E1, E2)**. We have fostered and established strong partnerships with external stakeholders across public, non-profit and for-profit sectors to ensure relevance with our strong focus on applied research enhancing impact. Notable examples include **Georgopoulos'** work on scalp cooling as a preventative measure for chemotherapy induced alopecia, **Hwang's** research assisting local government and communities to better manage their wild coffee resources and **Humphreys'** work with UK nuclear industry on effective radioactive waste disposal.

We have an active and vibrant public engagement programme **(E3)**. AS founded a hugely popular public lecture/discussion forum series communicating our research to members of the public; this has been maintained online during the current pandemic, with a focus on communicating our pandemic-related research contributions. In 2016 and 2017, the European Researchers '[Full STEAM](#) ([S](#)cience, [T](#)echnology, [E](#)ngineering, [A](#)rts and [M](#)aths) Ahead' night funded by the European Union's Horizon 2020 research and innovation programme was held in Huddersfield, with over **3000** members of the public attending each event. A number of staff have extensive public engagement activities detailed in section **4.2**. Finally, we actively pursue a policy of open access to our research as described in section **1.6**.

Staff performance is recognised and rewarded through annual Personal Development and Performance Review (PDPR) meetings and internal conferment procedures **(E4)**. Assessment of impact features in PDPR and promotion processes (see also section **2.1**). Institutional criteria for promotion were revised for 2020 to specifically include routes recognising excellence in knowledge exchange and enterprise as alternatives to excellence in research. Whilst the two routes are typically closely related, individuals whose research is more applied with a focus on knowledge exchange leading to impact can be recognised and appropriately rewarded.

In summary, we have successfully implemented our research and impact strategy over the current REF cycle: expansions in volume and quality of our research indicate the unit's vitality and point towards sustainability moving forwards.

### **1.5 Future strategic goals for research and impact**

Research strategic aims for the next REF cycle align closely with the University's 2018/25 strategy map. Overarching aims are to increase the quality, scope, reach, and impact of our research; key performance indicators are generation of high-quality outputs, increased research and enterprise income, increased emphasis on international collaboration and involvement of research beneficiaries. Aims for our research and impact strategy during the next REF cycle are:

- (A1) Promotion of interdisciplinary research in areas of existing strength and developing new areas, leading to impact upon patient welfare and/or society
- (A2) Continued development of contemporary core facilities and research laboratories, thereby enhancing our research environment, culture, outputs, and staff development
- (A3) Aligned with the University's strategy map, improved quality of research outputs with 75% or more of staff are achieving 1 or more 3\*/4\* publications every 2 years by 2025
- (A4) Increased research and knowledge exchange income and development of strategic research collaborations with world-leading academic institutions
- (A5) Continued support and development of existing staff
- (A6) Attraction of internationally-recognised, world-leading research-active staff to FTE and visiting positions, including increasing our 'critical mass' of research-active practitioners
- (A7) Expansion and diversification of nascent research at the interfaces of biological sciences, physical geography, and environmental science in order to return to UoA14 at the next REF census date.

To develop a strategic research portfolio associated with UoA14 (Geography and Environmental Studies), Professors Dilanthi Amaratunga and Richard Haigh (both returned to UoA13 for REF2021) have joined AS. Their world-renowned expertise in multi-hazard threats, particularly in Asia, offers excellent synergies with staff in UoA5 working in areas of remote sensing, biodiversity, coastal morphology, and biodiversity.

In summary, continued expansion and diversification of research activities will mean staff currently aligned with UoA5 and staff more likely suited for return to UoA14 at the time of the next REF census date will be contributing extensively to the recognition of the University as a world-class academic institution.

### 1.6 Research culture

Open Research: Institutionally, the University supports the principles set out in the Concordat on [Open Research Data](#) and is committed to the concept of open research. It has invested in systems to facilitate Open Research including the Elsevier PURE management information system and a University Data Repository and content management system (Box). Additional central support comes from the appointment of Open Access Manager and Research Data Management Officer whose roles are to assist in the delivery of mandatory central training for staff and students, to support the wider open research strategy and to assist academic staff in making data open and accessible. The University also subscribes centrally to support dissemination of research outputs as gold open access at point of publication in Springer and Wiley journals.

As a unit priding itself on its values in applied research that makes a difference, we seek to continually develop and nurture an open, collaborative research culture that embraces and engages partnerships with different external stakeholders. We achieve this through encouraging open, collaborative culture within and across Research Centres, through a vibrant public engagement programme and through strong commitment to user/public involvement and coproduction. We actively pursue policies of open access to our research, encouraging staff to integrate strategies into research proposals or maximise engagement with and use of research outputs by research users and different audiences.

Research Integrity: In the development and conduct of our research, we maintain adherence to high standards of Research integrity. Institutionally, we adhere to the UKRI-developed Concordat on Research Integrity and ensure research is conducted according to appropriate ethical, legal and professional frameworks, obligations and standards. The institutional [Code of](#)

[Practice for Research](#), research ethics and integrity policy and reporting statements are publicly available on the [University website](#). Within AS, research and integrity matters are co-ordinated by the School Research Ethics and Integrity Committee (SREIC) which is responsible for implementing the University's policies and procedures in relation to research governance. In addition, AS has a nominated Research Integrity Champion (Phillips) whose role is to promote good research practice, ensure that its principles and relevant standards are embedded into our research culture and to ensure advice is available to staff and students regarding the issue of research misconduct and the reporting thereof. Research Ethics and Research Integrity training of all staff and PGR students is embedded into the induction programme and assessment of research ethics is an integral part of all research and enterprise grant applications. In AS, research involving human tissues is conducted under the terms and conditions of the human tissue act (HTA licence number 12641) and compliance with the HTA is maintained through the Corporate Licence holder (Dr Tracy Turner), the Designated Individual (DI, **Georgopoulos**) and Persons Designate (PD) within each department. Research misconduct is taken seriously across the Institution: all matters pertaining to research misconduct for [PGR students](#) and [research staff](#) are pursued following Institutional guidelines.

## 2. People

### 2.1 Staffing strategy and staff development

Our staffing strategy emerges from our strategic aim to build a research base internationally recognised for the quality and impact of its research. Thus, we focused on continued development areas of expertise as described in REF2014 and expanded into new areas of research through the appointment of both experienced and early career academic staff. Of **13** academic staff returned in REF2014, **6** remain in post (**Bingham, Carr, Georgopoulos, Pala, Richards, Williams**) and are returned again plus **2** additional staff (**Laws, Morris**) remaining in post but returned in UoA8 for REF2021. **5** staff not submitted in 2014 are returned for REF2021 (**Burns, Clarke, Collett, Humphreys, Kinnunen**). The remaining **19** staff entered into REF2021 are new appointments since 2014. These appointments were made at professorial (**Ginger, Owen-Lynch**), reader (**Boyne, Hennies**), senior lecturer (**Allison, Bruning-Richardson, Bryk, Cooper, Fang, Fox, Hwang, Massey, Milner, Smyth**), lecturer (**Davidson, Hill, Rout, Wilson** (all now senior lecturers)) and senior research fellow (**Edwards**) levels. The appointment process is co-ordinated by Human Resources and research plays a key role in both short-listing and interview decision-making processes. Appointments were made in strategic areas to expand expertise and critical mass within longstanding key areas (e.g. around Molecular Medicine and Evolutionary Genomics) or to establish new research themes (at the interface of Biology and Physical Geography).

Looking beyond REF2021, the requirement for all appointed staff to show excellence in both research and teaching will remain. Our staffing strategy will continue to focus on staff appointments with excellent research experience covering University ASRIs, with School-level support for new appointments whose interests may cover other areas. In this way, the School provides the nimbleness to build timely research presence in new areas not necessarily immediately covered under the ASRI umbrella. Moreover, our focus is not just on appointing research excellent staff: we also provide a supportive environment for staff returning from career breaks. For example, during this REF cycle we appointed **3** Daphne Jackson Fellows within AS, the aim of which is to support women returning to academic life following career breaks to raise a family. Our staffing strategy will continue to support this approach. Contract researchers at various grades are appointed according to the needs of particular research projects and supported in their career development.

The University adheres to the principles of the UK Concordat to Support the Career Development of Researchers and is committed, as recognised by the European Commission's HR Excellence in Research Award, to the implementation of the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers. We support development and career progression of ECRs and existing staff (mid-career researchers, emerging and established research leaders) through research training, mentoring and coaching to support research career progression and by

actively developing opportunities for staff to gain first-hand experience in research. Research training is delivered locally and centrally: a clear interface ensures coordination, consistency and quality and all training is mapped to Vitae's Researcher Development Framework. Initiatives available to provide research training, mentoring and support for staff within UoA5 include one-to-one meetings with newly appointed staff to discuss research interests and expectations (these meetings are maintained during probation); funding and support for staff to undertake doctoral studies; and one-to-one research career mentoring from a senior colleague.

For new staff we offer a structured induction programme and we aspire to: one year of minimal teaching; tailored research mentoring; start-up financial packages for consumables; equipment purchases where appropriate; and priority over PhD scholarship student co-supervision. In AS, QR funding has been used to provide PhD studentships; strategically, these are awarded to new staff typically within two years of appointment to help establish/support their research or established staff with interdisciplinary research projects. Fully funded studentships provide new staff, in particular, with opportunity to get their research off the ground during the early part of their tenure. All staff are allocated time for research within the Workload Allocation Model; performance is monitored annually through the PDPR process. PDPR promotes, supports and celebrates excellence in research with an emphasis on researcher development and the establishment and monitoring of ambitious, but achievable performance targets around key research functions such as publishing. All academic and research staff in UoA5 are set research objectives within their annual PDPR.

Career development is another aspect of PDPR with staff development strongly supported through several approaches. This includes an annual promotion exercise undertaken following institutional guidelines. Thus, staff are promoted to Professor, Reader, Principal Research Fellow, Principal Enterprise Fellow or University Teaching Fellow, following a matrix with minimum threshold criteria applied to teaching, research, management/leadership and enterprise pertinent to each route. Promotion to Professor and Reader requires evidence of sustained internationally recognised research with an established track-record of high-quality publications, sustained ability to win external funding and a track record of research leadership. From Jan 2014 – Dec 2020, **9** staff in UoA5 were promoted to Professor (**Humphreys**), Reader (**Allison, Georgopoulos, Hwang**), Principal Enterprise Fellow (**Williams**), or Senior Lecturer (**Carr, Psakis, Rout, Wilson**). **2** staff were promoted to Subject Area Leaders (**Bingham, Kinnunen**) and in 2021, prior to the REF submission, **1** individual was promoted to research-active, University Teaching Fellow (**Bryk**) and **2** to Senior Lecturer (**Hill, Davidson**). Other opportunities for staff development include training in management and leadership skills, notably through Membership/Fellowship of the [Chartered Management Institute](#) (CMI): all (**12**) of the School Management Committee have achieved or are completing chartered manager status. As line managers, **Humphreys, Hwang, and Georgopoulos** are also working to achieve chartered manager status; **Ginger** and **Owen-Lynch** are Fellows of the CMI. **Kinnunen** has completed the women-only National Aurora Leadership Programme. All academic staff are required to obtain teaching qualifications by becoming [members of the Higher Education Academy](#) (HEA).

Underpinning support we offer is the general principle that staff should retain autonomy over their research careers and should not feel compelled to pursue particular research agendas other than to generate high quality research outputs leading to impact upon society **and** train the next generation of research active scientists/clinicians to the highest standards. The University is committed to Vitae's Concordat to Support the Career Development of Researchers and as a UoA, we provide a variety of mechanisms to ensure staff are supported throughout their tenure. Our strategy is to create an inclusive research environment and culture where staff are supported to be able to achieve increasingly more demanding targets. Looking beyond REF2021, our staffing strategy will continue along the lines described above. Strategic appointments in existing areas of strength and agreed new priority areas will continue to be made, reflecting the University's continued commitment to excellence in research, enterprise, knowledge exchange, teaching and learning as described in the 2018-25 strategy map.



## 2.2 Support for postgraduate research students

We foster a vibrant PGR community with close alignment to Research Centre themes and aspire to providing world-class PGR training and mentoring. Entry onto PGR courses is conditional on having a good first degree (at least an upper second-class honours) or relevant Masters' degree (typically at distinction). All prospective PGR students are interviewed by at least two academic staff, one of whom must be a senior academic and, if successful, assigned a minimum of two supervisors. The main supervisor must have a PhD **and** be publishing at an internationally recognised standard (co-supervisors will normally have a doctoral degree, but maybe new to supervision). Supervisors must also undergo an initial three-part training course with refresher courses every 3 years to update them regarding PGR regulations and processes. These criteria ensure students are assigned a supervisory team with the necessary research experience and expertise. AS has used QR support to create fully funded studentships across its full spectrum of research activity. Funding covers fees and a bursary together with a consumables budget ranging from £2,000 to £10,000 per annum depending on the nature of the project.

Since REF2014, the School has provided bursary and fee support to 79 PhD students of whom 26 were/are primarily supervised by staff returned to UoA5. A further 29 PhD students supervised by staff returned to UoA5 were/are funded by external awards. The total numbers of PhD students graduating in AS or in association with UoA5 are 142 and 44, respectively (numbers include self-funding students). We are also a member of the University Alliance Doctoral Training Alliance (DTA) for Applied Science for Health, a programme launched in 2015 with the aim of 'understanding and promoting healthy ageing'; we currently have **2** scholars supported under this scheme. There have also been **4** scholarships awarded to staff returned to UoA5 from the EPSRC Materials DTP held by the University.

Upon enrolment, students undergo a full induction programme covering research culture, expectations of supervisors and students, PGR degree rules and regulations, progression monitoring and research ethics and research integrity. Much of the training is delivered by each School, but at University level additional support and on-line resources are available through the [Graduate School](#). In common with training for staff, each element of PGR training is mapped to the Vitae Researcher Development Framework to ensure coverage and to avoid duplication (with discipline-specific training at School level and transferable generic skills training at University level). Research Integrity and Research Ethics are fundamentally important at all levels and students are informed of the Concordat to Support Research Integrity and the consequences of non-compliance at induction. Additional information about support for students is available on our Brightspace virtual learning environment and MS Teams. There are dedicated PGR-only study areas across the campus, with smaller, quieter rooms being available for PGR students writing their thesis.

Our PGR students are members of Research Institutes, Centres and Special Interest Groups and are encouraged to fully engage with activities, in order to ensure strong support from active researchers and opportunities for peer mentoring. PGR students are also encouraged and expected to attend (and deliver) research seminars (which is noted at progression points). Internal presentations are a condition of receipt of funding for external conferences. Many PGR activities are student-led including PGR seminar series, PGR Society and annual PGR conference. We maintain meaningful pathways to consultation with PGR students and have PGR student representation both on School Research Ethics and Integrity and PGR Committees. We encourage regular informal meetings of the PGR community in addition to online engagement.

Regarding development and progression, an 'open door' policy exists where students discuss research informally, but more formal meetings are held monthly and notes from both students and supervisors are recorded monthly in SkillsForge. PGR student progress is monitored via the University Postgraduate Progressions Board. Management of PGR matters are overseen by the School's Director of Graduate Education (DoGE, **Clarke**). Progression viva voce examinations are held after 9 and 21 months (full-time equivalent): students are required to present a report detailing progress and discuss research plans with at least two other academic staff who are not formally involved in the project or the supervision. For progression to be approved, examiners must be

satisfied that the student has made sufficient progress intellectually; data accrual is of sufficient quantity and quality to enable the thesis to be constructed; **and** future plans for completing the research plan are realistic within the timescale remaining. Research training needs are also discussed at this stage together with any issues that the students may have with supervision. Three PGR Progression Boards are run each year to track PGR progression, viva outcomes, misconduct, suspensions and timeliness of events. With regards to pastoral care AS have experienced senior staff that act as pastoral mentors for PGRs, overseen and including the DoGE. Cases that require specialist support are referred to the University's [Wellbeing Services](#) who have dedicated PGR provision

We also support students to develop their research and teaching careers through attendance and presentation at conferences; publishing their research; **and** contributing to undergraduate teaching sessions. With regards to conference attendance, students are encouraged to attend one national and one international conference during their studies and the School provides funding to support this. Attendance is conditional on presenting their research in the form of oral or poster presentations. Within this REF cycle, 72 PGR students in AS have received School funding to attend conferences. Prior to attending national or international conferences, students gain experience of presenting either orally or via posters at the annual PGR conference and 3-minute thesis competition. This provides PGRs opportunities to showcase their research and receive feedback on the strengths and areas for improvement (often before they present their work externally). Students also gain experience of presenting through other routes, including the Postgraduate Research Science Society, a student inspired initiative providing students with opportunities to present to peers and academic staff in a relaxed and supportive environment. In addition, students are encouraged to attend and interact with internationally renowned scientists as part of the School's seminar programme. Intellectual property is also an important consideration; experienced supervisors guide students through this process and Central University support is also available through Research and Enterprise, ensuring [intellectual property](#) is protected prior to disclosure. We encourage PGR students to see research and teaching as symbiotic and of mutual benefit; to this end, we provide students with opportunities to gain teaching experience. For School-funded students this is mandatory, but it is available to all students. Teaching is typically not lecturing but predominantly involves practical class demonstration, small group workshops/tutorials (with academic staff) and practical supervision of undergraduate projects.

Beyond REF2021, we are developing pipelines for recruitment into Research Masters and PhD programmes. These include new research-active taught MSc programmes in Cancer Biology, Cancer Therapeutics; Biomedical and Analytical Sciences; and Environmental and Remote Monitoring. Finally, our undergraduate students through honours-level dissertations have independent opportunity to publish their research via open access [Fields](#) student research journal overseen by Huddersfield University Press. Students supervised by staff returned to UoA5 (**Bingham, Brüning-Richardson**) have ([Vol-2-in-2016](#)) or will (in Vol 7) publish in the journal.

### 2.3 Equality and Diversity

As described in the institutional environment statement, the University is passionate about [equality, diversity and inclusion](#) (EDI) in all aspects of its business. The Institution has established the University Equality, Diversity and Inclusivity Enhancement Committee (UEDIEC) to oversee the implementation of University [EDI framework](#) and related policies, Code of Practice, frameworks and schemes for staff and students. In 2020, the University signed the [Race Equality Charter \(REC\)](#) and is working towards equal representation of women at most senior levels. Other examples of equality work include enhanced support for [Black Asian and Minority Ethnic \(BAME\)](#) students across the Institution. The University is a [Stonewall Global Diversity Champion](#) member thereby demonstrating its commitment to supporting LGBT+ and disabled staff and students; **and** the University is a [Disability Confident Employer](#). These and other institutional level policies (described in the institutional ES) impact upon the composition of committee structures and policy within each School. The University participates in Vitae's 'Every Researcher Counts' to improve equality and diversity for researchers within higher education

and EDI is an important aspect of our commitment to the Concordat to Support the Career Development of Researchers and our HR Excellence in Research Action Plan.

School of Applied Sciences has long been committed to promoting gender equality in science. This is evidenced by achieving Bronze Athena SWAN status in 2015, followed by Silver level accreditation in 2018. AS champions good practice and is the highest Athena SWAN award level holder in the University; some of its staff act as internal consultants or critical friends to other Schools. Many initiatives related to gender equality have been developed and trialled in AS and then either rolled out to the whole University or shared with other Schools. AS' Athena SWAN committee expanded in 2018 to become the Equality, Diversity and Inclusion Committee, so that its remit widened to include all aspects of equality work. This approach was later mirrored by the University as a whole, evidenced by the formation of UEDIEC (described above) which reports directly to Senate. AS constantly strives to create an inclusive and supportive environment for its researchers and makes considerable effort to maintain an excellent mentoring programme, abide by a Core Hours system, support career progression and applications for promotion, develop case-by-case enhanced maternity provision and support in order to maintain or re-establish (through the award of 3 Daphne Jackson Fellowships) research momentum, support flexible working, and provide access to women-only national initiatives such as the Advance HE Aurora scheme (taken by **Kinnunen** in UoA5 and **5** other scientists in AS).

With regard REF2021, the Universities Equality and Diversity Impact Assessment looked at all protected characteristics with regards to the SRR/IR identification selection process but of these, only gender showed an overall impact. Of all the UoAs submitted by the University to REF2021, UoA5 had one of the largest variances in favour of males (38.89%) with regard to the identification of staff as SRR/IR. The main reason why staff have been identified as not-SRR is they are presently ineligible to act a main supervisor for doctoral students, either because they are not yet qualified with a doctorate themselves or they have a doctorate but are not yet engaged in international quality research. The output selection process for REF2021 was based first and foremost on the quality of outputs as determined by both internal and external review. Where outputs of equal merit were identified, outputs were chosen to ensure diversity of staff was employed. An Output Equality Impact Assessment for UoA5 reported that a total of 11 female (36.7%) and 19 male (63.3%) staff were identified as SRR/IR. Using the output selection criteria described above, 33.3% and 66.7% of outputs were submitted from female and male staff respectively. This broadly reflects the SRR/IR gender distribution within this UoA.

### 3. Income, infrastructure and facilities

#### 3.1 Income

For UoA5, income during this REF cycle was £3,167,014. The majority of our income (£1.316M) comes from UK based charities (open competitive and other processes) with other significant funding coming from UK Industry, commerce and public corporations (£351K), UK industry, commerce, public corporations (£382K) and EU government bodies (£314K) and Research Councils £570K) – notable awards in the current REF cycle are summarised in Section 1.4 (**A3**). Significantly, income for UoA5 has grown considerably since REF 2014 when the total awarded was £318,362. Beyond external funding, AS used QR funding and other strategic university support within this REF cycle to support PhD studentships (£4.449M) and equipment (£2.310M relevant to UoA5).

Increased research income generation is foregrounded in the University's 2018-25 Strategy Map and central support is provided by Research and Enterprise. Particular to UoA5, our forward-looking strategy will be to use central support to pump-prime research with applied potential, thereby keeping our unit competitive for funding from diverse external sources, offering opportunity for contemporary publishing, and speaking to our strategy (**1.5 (A6)**) to recruit research-active practitioners. To assist academics in external bidding, central support for research grant applications and commercial contracts is available following appointment of a dedicated research development manager (RDM) and a business development manager (BDM) for AS. To support commercial ventures, the BDM oversees all contract development, NDAs, liaison with the Legal

department and IP protection, as well as maintaining familiarity with all aspects of available commercial funding and government initiatives specifically aimed to develop academic/commercial collaboration. Through distribution of QR funding to Schools and University level support via the University Research Fund (URF), the institution invests in research through provision of PhD studentships and funding to develop ASRIs. New ventures can be supported internally by seed funding administered by central Research and Enterprise, the Collaborative Venture Fund (CVF). Promotion of international research partnerships is key to the 2018-25 Strategy Map and central funding to support this has been awarded (currently £57.7K).

### 3.2 Infrastructure and facilities

AS provides dedicated research laboratories housing state-of-the-art equipment for molecular biology, microbiology, pharmacology, cell biology, analytical sciences and ancient DNA research. Furthermore, AS has four computer suites dedicated for bioinformatics research. The School has continued to make a major financial commitment (£3.282M, £2.310M relevant to UoA5) to strengthening our research facilities and infrastructure and laboratories have been renovated, thereby increasing capacity as well as the provision of excellent, contemporary research space. Outside of AS, **Hwang** has deployed multiple research instruments on the Arctic sea ice. These deployments, supported by NERC/UKRI involved German research icebreaker Polarstern as the base station, with logistical support from Russian icebreaker Kapitan Dranistyn.

Leading up to REF2014, one focus was establishment of a state-of-the-art facility for ancient DNA research (at a cost of ~£375,000); this facility has completed during the current REF cycle. AS has also invested in protein purification facilities, with the purchase of AKTA Pure FPLC and AKTA Start machines at the cost of ~£35,000. To analyse the Big Data projects undertaken by staff in UoA5, the School paid ~£50,000 for a 8-node mini-cluster, with 4 high-processing nodes (96 cores each with 2Gb RAM) to meet needs of staff processing environmental data and 4 high-RAM nodes (40 cores with a total of 1.5Tb RAM) to support high memory computations associated with genomics research. Four new computer suites have been built within the current REF cycle, with a total of 72 HP PCs and 67 Stone PCs for use by PGR students across all departments in the School.

Renovation of teaching laboratories into research laboratories resulted in expansion of our cell culture facility, which now has 12 class II hoods (up from 4 class II hoods in 2014). This sits immediately adjacent to a pharmacology and cell biology laboratory housing up to 24 research students and staff. Maintenance and day-to-day running of these laboratories is supported by a dedicated technician funded from University Research Funds. A smaller cell culture unit dedicated to stem cell research was created through renovation of existing space within AS. There is also extensive anaerobic and microaerophilic culturing capacity for microbial and cell biology research. Following a successful application for a human tissue licence in 2016, the cell culture facility is permitted and equipped to process human tissues and generate primary cell cultures for analysis. This directly led to expansion in the scope of research that can be conducted in Research Centres for [Cellular and Molecular Models of Disease](#) and [Pharmacology and Therapeutics](#).

Other significant developments include establishment of a [cell-imaging facility](#) housed in the University's 3M Buckley Innovation Centre and funded via a Local Growth Fund grant of £2.9m. These facilities are run by a dedicated senior research fellow (**Harmer**). This facility houses a confocal laser scanning microscopy with Airyscan technology for super-resolution imaging and a widefield epifluorescence microscopy based on an Axio Observer Z1 platform. These microscopes provide capacity beyond scanning electron microscopes available in AS and helped enable staff in UoA5 to develop experimental models in mammalian and microbial cell biology (including for 3D cultures, co-cultures, organoids, biofilm imaging, FRET and FRAP analyses, and assays of cell motility).

Further investments have facilitated increased capabilities in analytical and molecular biology capability generating excellent facilities for target validation of drug action, state-of-the-art qRT-PCR, pharmacogenomics, bioinformatics and metabolomics. We have also invested in novel



technologies to support staff development (particularly ECRs) including purchase of surface dissolution imaging and an Agilent seahorse XF metabolic analyser, for example.

New investments summarised above are complemented by the availability of wide-ranging facilities for analytical and structural biochemistry. Our NMR facility comprises of open-access 400 MHz and 300 MHz multi-nuclear instrumentation along with a 600 MHz instrument with a cryo-probe for non-routine, dedicated technician-controlled analyses. The latter two instruments were recently purchased as part of a £650K programme to increase NMR facilities and, as with all resources available to researchers within AS, is free at the point of use for non-externally funded research. We also have a dedicated X-ray diffraction facility that houses three powder X-ray diffractometers (benchtop, high temperature and a D8 Advance), a small-angle X-ray (SAXS) and two single-crystal X-ray instruments (dual source Bruker Duo and Advance). The Advance diffractometer was upgraded recently with a new detector (~£60,000). The analytical facility includes 8 HPLC and GC instruments, ion chromatography, capillary electrophoresis, 2 GC-MS and a LC-MS.

In 2010, AS was awarded a £2.3M ERDF grant which, together with matched funding from the University of £1.3M, enabled the establishment of Innovative Physical Organic Solutions (IPOS), a GMP accredited facility (licence number UK GMP 43253) and Agilent Centre of Excellence. IPOS provides analytical expertise to both external businesses and academics within Applied Sciences and across the University and is a focus for analytical research with facilities include LC/MS, GC and GC-MS, ICP-MS, GPC-MALLS and ion chromatography. We also enjoy ready access to equipment in the School of Computing and Engineering including atomic force microscopy, x-ray tomography and infinite focus microscopy.

Looking beyond REF2021, AS expanded its [teaching laboratory space](#) in 2019, releasing former teaching space for the development of additional high-quality research facilities during the next 2-3 years.

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

##### 4.1 Collaboration, Industry and Economy

Our international collaborative links span the globe. Collaboration was an essential strategic element contributing to success in achieving objectives laid out for REF2014 (1.2) and is exemplified by a SciVal analysis for UoA5 (Jan 2014 - Nov 2020) where 56.8% of outputs include international partners. Examples of our international collaborative work include:

- Staff from the **Centre for Evolutionary Genomics (CfEG)**, led by **Richards** have active collaborations with over 30 institutions including Harvard, Oxford and the Max Planck Institute. These collaborations include an extensive network of archaeologists and cultural experts who facilitate access to samples, archaeological sites and provide invaluable context to the archaeogenetic research. These collaborations have led to major publications in Nature (2016) and Science (2019).
- **Bryk** has established a pan European network of collaborators to support his research in the ecology and evolution of rodents and Mustelidae including the Polish Academy of Sciences' Mammal Research Institute, the University of Liege (Belgium), the National Museums of Scotland and the Max Planck Institute for Developmental Biology in Tübingen. These collaborative links have resulted in outputs in journals such as Proceedings of the National Academy of Science USA (2016).
- **Hennies** has extensive international collaborations across Europe (University Hospitals of Münster, Cologne and Freiburg, Germany; University Hospital of Groningen, The Netherlands; Medical University of Innsbruck, Austria; University of Paris, France), Israel (University of Tel Aviv), Tunisia (Farhat Hached University Hospital) and Canada (University of British Columbia, Vancouver). These collaborations have led to a series of publications in the British Journal of Dermatology, a leading journal in its field.
- **Humphreys** work on radioactive waste disposal includes work for the Canadian Nuclear Waste Management Organisation (NWMO) has generated an impact case for REF2021. More

recently collaboration with the State of Nevada, USA on the proposed Yucca Mountain Facility has also been established.

Collaborations with national/local government, their agencies and non-governmental organisations (NGOs) include the Environment Agency, National Trust, Calder and Colne Rivers Trust, and River Holme Connections (**Milner**). Collaborations with industry partners are supported by the University's CVF that pump-primed early connections between industry, academics and 3M BIC innovation centre. CVF pump-priming includes characterisation of fermented foods Kefir and Kombucha for SME's to optimise product stability and shelf life (**Humphreys** and **Rout**). CVFs were also used to establish research collaborations with a wide range of companies in the healthcare sector to develop, test and commercialise disinfection technologies, many of which are now in use within the NHS (**Humphreys** and **Rout**). Other CVF projects include collaborations between **Allison** and CytoSmart Technologies (The Netherlands) on optimisation of imaging devices for cancer and hypoxia related research. Our highest profile industrial collaboration within UoA5 is the partnership with Paxman Cooling Ltd; this created the [PAXMAN Scalp Cooling Research Centre](#) (PSC) with a total investment of £1M over five years. The centre focuses on management of chemotherapy induced alopecia through scalp cooling. This is the culmination of active research in this area since 2011 by UoA5 staff (**Collett** and **Georgopoulos**). There is also a successful spinout of skin repair technology in the form of the company VeritaCell (**Georgopoulos**), which is now at a stage of seeking regulatory approval for planned 'in use' trials. An earlier spinout point is ThanatoCure (**Georgopoulos**), a combinatorial therapeutic approach specifically targeting malignant cells in bladder, colorectal and renal/kidney tumours. The treatment is currently undergoing in vivo evaluation with a view to acquiring further development funding.

#### 4.2 Contributions to the research base and society

Staff in UoA5 are committed to providing service to the wider research communities, economy and society. Evidence includes:

Editorial positions: Editorial board positions include: Royal Society journal Open Biology (Ginger), Methods in Molecular Biology (volume 2116 **Ginger**), Molecular and Biochemical Parasitology (2012-20 **Ginger**), Bioscience Reports (**Cooper**), Biomarker Insights (**Cooper**), Cellular and Molecular Pathology (**Boyne**), Crime, Security and Society (**Williams**), Forensic Research and Criminology International Journal (**Williams**), Food Biophysics (**Bingham**), Frontiers: Structural Biology, Cellular Biochemistry and Archaea section (**Cooper**), Frontiers: Structural Biology of Membrane Transport and Signalling: New Insights and Developments (**Bingham**), Hematology and Leukaemia (**Cooper**), Host and Viruses (**Brüning-Richardson**), Journal of Forensic Research and Analysis (**Williams**), Journal of Forensic Sciences and Digital Investigation (**Williams**), PeerJ (**Cooper**), Protist (**Ginger**), and The Police Journal (**Williams**).

Plenaries and invited lectures: External recognition of our work is exemplified by the growing number of invitations to speak at national and international events. During the current REF period, unit staff have provided ca 90 invited presentations both nationally and internationally, of which 7 were keynote or plenary lectures.

Committee membership and conference organisation: Academic staff in UoA5 are active members of a wide range of committees and working groups, examples of which include: European Pond Conservation Network (**Hill**); Institute of Food Science and Technology; Microbiology Society, Prokaryotic Division, (**Cooper**), Mineralogical Society, Geomicrobiology Committee (**Humphreys**), Protistology-UK (**Carr**, Society Treasurer since 2012); medical and scientific advisor for both the Ichthyosis Support Group UK and German Ichthyosis Support Group patient organisations (**Hennies**).

Academic staff in UoA5 are active in conference organisation. Examples include: International Inter-Professional Skin Integrity And Infection Prevention Conference, 2016 and 2017 (**Georgopoulos**), International Dermatology Congress, 2017 and 2018 (**Hennies**), British Association for Cancer Research, Leeds (**Brüning-Richardson**), British Neuro-Oncology Society

2016 Leeds (**Brüning-Richardson**), British Society for Protist Biology Spring Meeting 2015, Huddersfield (**Carr**), Cologne Genomics Days, Germany (**Hennies**), Controlling Cancer Summit 2016, London, UK (**Georgopoulos**), European Pond Conservation Network 2020 (**Hill**), North of England Cell Biology 2017 (**Boyne**) and 2018 (**Allison/Cooper**), Northern Bioinformatics User Group Steering Committee (**Bryk**), and 2017 Yorkshire University Evolution Group (**Carr**).

Public engagement: AS has an active, vibrant public engagement program (section 1.4). Additionally to examples cited earlier, academics and PGR students contribute to events including Otley Science Fair, Sceptics in the Pub, Pint-of-Science and British Science Week. AS promotes its science, whilst assisting secondary school education, by providing an A-level Practical Activity Groups series in newly constructed dedicated outreach laboratory. AS science has also featured in the [arts meets science exhibition](#) 2019 (**Brüning-Richardson**). **Richards** genetic chronology for the Indian Subcontinent (BMC Evol Biol 17: 88) generated much interest in India, featuring in The Hindu (second most circulated English-language newspaper in India). **Pala** and **Edwards** were involved in award-winning 2018 Smithsonian documentary 'The Ice Bridge'. **Richards** was involved in 2015 S4C series 'DNA Cymru' and his work on American settlement featured in 2014 Korean TV documentary 'Panorama: Korean Eve'. **Richards** also provides commentary for popular magazine New Scientist and his collaborative work with Harvard on the genomic history of the Iberian Peninsula featured in news and magazine outlets, including National Geographic and BBC News. Explaining his research on rodenticide resistance in rats **Clarke** has made multiple domestic and overseas (USA and New Zealand) television and radio appearances, as well as featuring in over 50 newspaper articles.

Response to Covid-19 pandemic: Similar to other universities we supported local health care providers: AS donated all its PPE stocks (**Mar 2020**) and has loaned a -80°-freezer for vaccine storage to Huddersfield Royal Infirmary (**Dec 2020**). AS also provided the Covid-19 National Testing Programme its ThermoFisher 7500-Fast PCR system (Apr-Dec 2020). Contribution to the science base included publication in Pathogens ([doi:10.3390/microorganisms8111678](https://doi.org/10.3390/microorganisms8111678)). **Richards, Pala**) of the identification of Europe as the main source of virus spread; wide dissemination of the study across Europe concluded in an interview with La Republica (**Pala**). Structural modelling of Sars-CoV-2 'orphan' proteins (**Cooper**) has also supported training of a PGR student.