Institution: Cardiff University

1. Context and mission

1.1 Mission

Cardiff is a research-intensive institution driving societal and economic change benefiting Wales, the UK and the world. Since REF2014, our strategic objectives for research, innovation and impact (hereafter R&I) were:

- growth in early career academics and researchers (ECRs) (Section 3, hereafter S3)
- developing an inclusive research community and culture (S2-3)
- facilitating interdisciplinarity (e.g., via University Research Institutes, S2)
- delivering positive societal impact (S1.3)
- establishing cutting-edge R&I infrastructure (e.g., Innovation Campus, S4.4).

Successful delivery ensured **Cardiff achieved £150m research awards in 2019-2020** (its highest ever).

1.2 Structure

Cardiff is the 8th largest Russell Group University by student numbers (20,995 undergraduate; 5,395 postgraduate taught; 1,880 postgraduate research (PGR)), with 2,235 academic and research staff (1,225 Teaching and Research (T&R); 1,010 Research-only (R-only)).

Three Colleges (established 2012) facilitate collaboration within and between disciplines:

- *Arts, Humanities and Social Sciences* (12 UOAs; 10 Schools [Business; English, Communication & Philosophy; Geography & Planning; History, Archaeology & Religion; Journalism, Media & Culture; Law & Politics; Modern Languages; Music; Social Sciences; Welsh])

- *Biomedical and Life Sciences* (4 UOAs; 7 Schools [Biosciences; Dentistry; Healthcare Sciences; Medicine; Optometry & Vision Sciences; Pharmacy & Pharmaceutical Sciences; Psychology])

- *Physical Sciences and Engineering* (7 UOAs; 7 Schools [Architecture; Chemistry; Computer Science & Informatics; Earth & Environmental Sciences; Engineering; Mathematics; Physics & Astronomy]).

With a focus on inclusion, at **1,406.3 FTE, Cardiff's REF submission is almost double REF2014 (737.7 FTE)**. It comprises all Cardiff's T&R staff, and R-only employees identified as researching independently. Twenty-three UOAs, including three across Schools (UOA3; UOA4; UOA26), further showcase scale and disciplinary breadth, alongside significant growth in interdisciplinarity. REF2021 delivery is covered in S3.6.

1.3 Positive societal impact

Building on Cardiff's REF2014 2nd placing for impact, staff are actively supported to deliver impact with national and international reach, facilitated by close working with beneficiaries (e.g., NHS Wales), strategic partners (e.g., Office for National Statistics, linked to Cardiff's *Data Innovation Research Institute*) and governments. Cardiff researchers delivered major policy impacts on legislative reform (UOA19); hate crime (UOA21); fertility (UOA4); low-carbon housing (UOA13). Research with museums safeguarded historic artefacts (UOA15) and changed commemoration of war (UOA26). With the NHS we changed approaches to organ donation (UOA28); child oral health (UOA3); and developed new treatments for prostate cancer, postpartum bleeding and kidney disease (UOA1). Partnership with multinationals generated new technologies: cybersecurity malware prediction systems for Airbus (UOA11) and a waste recovery strategy saving Tata Steel £44m (UOA12). A successful commercialisation strategy benefited from major European-funded Data and Medtech Innovation Accelerators (UOA1; UOA11), complemented by Innovation Incubators (Medicentre; Innovation Centre, S4.4). Evidencing this significant impact, a London Economics report (2018) concluded that Cardiff contributes £3.2bn to the UK economy and £2.4bn to the Welsh economy each year, supporting almost 1 in 130 jobs in Wales.

2. Strategy

2.1 University strategy

The Way Forward (TWF) 2013-2023 strategy has three R&I KPIs: (a) delivering an inclusive REF2021; (b) growing research income; and (c) nurturing innovation. Consultation, open research, early-stage funding, interdisciplinarity and outstanding professional services (S4) underpins successful KPI delivery.

2.1.1 Consultation

Cardiff's R&I strategy is overseen by the Pro-Vice Chancellor Research, Innovation and Enterprise (PVCR), jointly led with College Deans for Research and Innovation; International; Postgraduate Studies. University Deans (Equality, Diversity and Inclusion (EDI, 2018); Research Environment and Culture (2019)) augment this **gender-balanced leadership team.** Alongside Welsh Language and Environmental Sustainability Deans, these senior leaders work consultatively with Directors of Research and Impact (DoR) from Cardiff's 24 Schools, aligning School-College-University R&I ambitions, and supporting transparent decision-making.

Inclusive consultation is a vital part of our strategy. Our **DoRs Network** (chair PVCR) is a collaborative space for Deans, DoRs, University Research Institute (URI) Directors and professional leads to share best practice, develop consistent approaches, support disciplinary needs and interdisciplinary opportunities, and deliver REF2021. Committees (e.g., Open Research, Integrity and Ethics; Equality and Diversity) and Task and Finish groups (e.g., REF2021 policies; grant peer-review; EDI; innovation strategy) include T&R, R-only, professional services and technical staff, as well as PGRs. ECRs (n=49) are members of University R&I bodies and School Research Committees. College Postgraduate Forums, and Researchers Pathway, DORA and EDI Groups (led by Deans), further ensure inclusive research culture is embedded across R&I delivery.

2.1.2. Open research, with integrity and transparency

Cardiff is committed to open and reproducible, fair and inclusive, research. We are signatories to the **San Francisco Declaration on Research Assessment (DORA); Concordat to Support the Career Development of Researchers; Concordat to Support Research Integrity**; and the **Technician Commitment.** Science Council Employer Champion Status was awarded (2019) for supporting scientific staff professional registration.

Our R&I strategy includes action plans for: (a) EDI; (b) DORA; (c) open research; (d) research integrity. Research integrity training is mandatory for researchers; staff are also required to have ORCID iDs. The PVC Biomedical and Life Sciences is the Establishment Licence Holder for Animals (Scientific Procedures) Act 1986 and Chair, Human Tissue Standards Committee. School leads ensure consistency and compliance, monitored by the Open Research, Integrity and Ethics Committee (chair PVCR).

Cardiff is part of the **UK Reproducibility Network**, with School Open Research Champions supporting staff and leading our open research plan. The **Library Open Research Team** (S4.3.2) supported REF2021 preparations, including management of Cardiff's Open Access (OA) repository, with 30,000 full-text outputs, and >3 million downloads per annum (p.a.). Since 2013, researchers deposited articles 3 months post-acceptance, with OA compliance recorded since 2014. Block funding and **an Institutional OA Fund (£1.4m)** facilitated 1,233 Gold OA outputs. **Cardiff University Press** (established 2015) supports OA journal articles and monographs (publishing 102 articles, with 14,000 downloads, from 111 countries in 2020).

2.1.3 Early-stage funding

Investment in early-stage R&I aims to catalyse larger-scale success; since REF2014, **£18.5m external funding** (UKRI, HEFCW and other funders), complemented by additional University investment, supported staff with: (a) proof-of-concept research; (b) transition to independence applications; (c) impact and commercial outcomes; (d) new international collaborations; (e) civic mission and public engagement; and (f) to purchase equipment (S4.3; S4.2.2). Two examples of many are provided below (see also UOAs' REF5b):

Cardiff's £7m (£3.5m institutional match) **Wellcome Trust Institutional Strategic Support Fund (ISSF)** supported: (a) 39 fellowships and ECR first grants; (b) 56 interdisciplinary projects; (c) 23 early-stage translational kickstarts; and (d) 28 public engagement initiatives. Translational kickstarts to *Stanton* and *Sewell* enabled £750k MRC funding with industry, and a £2.3m investment from Ervaxx, respectively. *Fasano*'s ISSF fellowship facilitated £1.5m MRC funding, and an independent academic position. **JAMMIND's** video games featured positive portrayals of mental health; **Superbugs,** a pop-up science shop, engaged 6,500 shoppers on antimicrobial resistance (*"Excellent to see my children become new champions in the fight against antimicrobial resistance. We learnt using antibiotics only when needed, and completing the full treatment course, even if you feel better can help protect you").* ISSF developed new EDI approaches, applicant mentorship and constructive feedback, informing revisions to Cardiff internal funding schemes (S3.1). Inclusion of ECR grant panel observers (n=107) improved funding assessment knowledge (e.g., "*Being an observer on the ISSF panel was hugely useful and probably one of the most useful training exercises I have completed at Cardiff University").*

HEFCW GCRF funding (£3.8m) and £600k for our **International Collaboration Seedcorn Scheme** supported 161 international projects, including with Cardiff's **International Strategic Partners** (KU Leuven; Xiamen University; Bremen University; Beijing Normal University; Brazil's Universidade Estadual de Campinas (UNICAMPS); University of Namibia). For example, Cardiff's *Water* URI leads our £860k interdisciplinary GCRF catalyst on water and food resilience with UNICAMPS and Namibia. Funding supported *Healy's* £1m UKRI Future Leaders Fellowship on global water shortages in Sub-Saharan Africa, *Bagshaw*'s novel wireless sensors for sub-ice measurements with University of Copenhagen (EPSRC, £230k), *Scofield*'s BBSRC GCRF research on essential oil feedstocks in Uganda (£816k) and *Brown's* ESRC GCRF award on protracted displacement in an urban world (£532k).

2.1.4 Interdisciplinary research

Cardiff invested £30.1m in flagship **University Research Institutes**, focused on interdisciplinary societal challenges (e.g., mental health; water; catalysis; cancer; crime and security). **These generated over £210m in external funding since REF2014.**

Cardiff's *Crime and Security* URI was awarded £8.5m in external awards, with research used by the UK Government, the European Union and police Counter-Terrorism Command to mitigate harm from disinformation campaigns (UOA21 impact case). Our *Energy Systems* URI leads FLEXIS (£24m, with Tata Steel, Swansea and South Wales Universities), focused on new flexible energy systems, including mine water heat recovery, real-time energy modelling and management of electrical grids (UOA12 impact case). *Energy Systems* URI researchers also support the £35m (Cardiff, £821k) EPSRC Active Building Centre (developing energy efficient smart buildings). Interdisciplinary collaboration between geneticists, immunologists, clinicians, biologists, bioinformaticians, psychologists and social scientists, via our *Systems Immunity* and *Neuroscience and Mental Health* URIs, led to **three new Centres** (spanning UOA1/UOA4/UOA5): £1m Hodge Centre for Neuropsychiatric Immunology; £10m Wolfson Centre for Adolescent Mental Health; £23m MRC UK Dementia Research Institute Centre (further examples, S4.1).

URIs additionally grew our interdisciplinary ECR training such as the **19 Doctoral Training Entities (DTEs)** Cardiff leads/co-leads, many with Universities in the **GW4 Alliance** (Bath, Bristol, Cardiff, Exeter). For example, the *Systems Immunity* URI, with Bristol and Exeter, delivers the £5.2m GW4 Wellcome Trust Clinical Academic Training Programme for medical, dental and veterinary ECRs; *Water* URI leads the £3.8m GW4 NERC Freshwater Biosciences and Sustainability DTE; *Energy Systems* is part of a £5m (Cardiff, £1.5m) EPSRC DTE on decarbonised resilient fuel energy systems, with Nottingham and Sheffield Universities. The *Water* URI also drives the *GW4 Water Security Alliance* (involving 200+ interdisciplinary scientists); this facilitated a €6.6m (Cardiff, £1.1m) Horizon 2020 award on climate change resilience in the Horn of Africa.

Smaller-scale (£90k) interdisciplinary **University Research Networks (URNs)** complement URIs (e.g., on antimicrobial resistance; material sciences; brain imaging). Our *Transport Futures Network* focuses on electric and autonomous vehicles and builds on Cardiff's EPSRC (£1m) decarbonising transport through electrification network and £3.9m Electric Vehicle Centre of

Excellence. The network also leads a **Cardiff Interdisciplinary Training Hub** on Sustainable Transport (funded by our EPSRC Doctoral Training Award). Other Interdisciplinary Training Hubs, aligned to R&I strategic training objectives, include: Sustainable Plastics (*Catalysis* URI); Cybersecurity Analytics; Physics of Life; Biosensors and Diagnostics.

Building on these interdisciplinary successes, from 2022, Cardiff will invest £5m p.a. in 5 new University Innovation Institutes (UIIs) and up to 10 disciplinary-focused URIs. A refreshed portfolio of interdisciplinary URNs will augment this major investment, alongside continued strategic use of PGR training awards.

2.1.5 Research leave

Complementing UOA research leave schemes, the £3.4m **University Research Leave Fellowship Scheme** funded 234 awards (2014-2019), providing time to write monographs, develop grants, learn techniques and establish collaborations (for outcomes, see UOAs' REF5b). Our new **Disglair Lectureship Scheme** (launched 2019, £2.7m) supported a further 59 staff to take research leave, including those new to the University. *Redmond* used his Disglair leave to submit a £1.8m MRC DPFS award (subsequently awarded post census date). A unique feature of Disglair is its complementary focus on supporting ECR transition into a first T&R position, with reduced teaching, research funding and bespoke cohort training. **This scheme recruited 20% more female lecturers compared to Cardiff's normal T&R recruitment.** Klemencic, now permanent lecturer in Physics, noted: "*The Disglair scheme has been absolutely transformational. The bespoke training plan, spanning academic practice through to funding applications, helped me develop my teaching, receiving the best module evaluations in my school, while exploring my own research interests, for which I have been awarded a prestigious EPSRC New Horizons grant.*"

2.2 Impact strategy and investment

S1.3 evidenced Cardiff's commitment to positive societal impact. Since REF2014, we invested in a professional services impact team, increased workload allocations and impact accelerator funding, and developed an integrated Innovation for All strategy, linked to our reinstated **£6.7m HEFCW Research Wales Innovation Fund** (RWIF, S4.2.2). The impact team deliver training, funding and partnership support, complemented by our **Commercial Development team**, supporting IP, start-ups and commercialisation (S4.4.1). A new impact module for ECRs focuses on pathways to impact (n=237). Impact secondments are strongly encouraged, e.g., UOA11 facilitated secondments to Airbus and Thales aligned to a new Welsh *Cyber Innovation Hub*; UOA27 supported secondment to Welsh Government, facilitating Welsh language development (impact case). The current Welsh Government Children's Commissioner for Wales was seconded from UOA21.

£7.7m of **UKRI Impact Accelerator Account** investment supported 299 impact projects, many leading to REF2021 impact cases (see UOAs' REF5b). A new **Wellcome Trust Translational Partnership** (£600k) supported biomedical translational research, complemented by MRC commercialisation accelerators (S4.4.1). This co-ordinated and strategic investment diversified external partnerships (e.g., UK Fire and Rescue Service; Crimtan; David Brown Santasalo; Costain; Living Wage Foundation; United Nations Economic Commission for Africa; Historic Royal Palaces).

2.3 Civic mission and public engagement

The University supports **Transforming Communities** projects**,** complemented by early-stage civic mission and public engagement. Major projects included: revitalising local journalism (UOA34 impact case); development of Cardiff's impoverished Grangetown area, including a new Grange Pavilion community space; our School Governor Initiative (56 staff governors on 47 school bodies donating 746 days, supporting the education of 22,750 children). Our award-winning CAER Heritage project involved co-production with community organisations, with public and school engagement based on an Iron Age hillfort in a socially deprived Cardiff area (UOA28 impact case).

Research-led public engagement is accessed by 247,000 people p.a., exemplified by Gomez's MBE for outstanding public engagement in Physics (UOA9 impact case). Sponsorship of events (National Eisteddfod (2018); Tafwyl Festival (2019); Hay Festival (since 2016)) helped 304 researchers undertake public engagement on topics ranging from multilingualism and literary

geography to asteroid research. Our civic mission also promotes Wales' bilingual culture, with UOAs 26/27, and the Welsh Language Dean, delivering initiatives supporting the Welsh Government's Cymraeg 2050 ambition for 1m Welsh speakers by 2050.

2.4 Future R&I strategy

Cardiff is committed to growing and diversifying R&I, ensuring we contribute to the UK's successful recovery from the economic and social impacts of Covid-19.

Short-term, we will:

1. Re-establish our research fully on campus, physically re-uniting our research community, accelerating delivery of their research ambitions and careers.

2. Address research inequalities caused by the pandemic (e.g., continue to provide funding support, research leave and initiatives for most-affected PGRs and staff; revise promotion and hiring practices to focus on achievement relative to opportunity).

Long-term, we will:

3. Work jointly with UOA R&I leaders to ensure co-ordinated realisation of future disciplinary and interdisciplinary aims within REF5b statements, facilitated by strategic use of HEFCW and funder investments, in a transparent and equitable manner.

4. Deliver an ambitious research culture plan, focused on ECRs, assessment, integrity, open research, teams and EDI, led by the Dean of Research Environment and Culture.

5. Ensure the success of our new University Innovation Institutes and interdisciplinary Centres of Excellence, facilitated by nurturing key academic-business partnerships, at the heart of our £300m Innovation Campus.

3. People

3.1 Equality, diversity and inclusion

Each University Executive Board member champions a protected characteristic, including socio-economic status. Cardiff is the **highest ranked Stonewall Workplace Equality Index** HEI employer (10th), and the first UK university named a **Living Wage Champion** (2015). Cardiff's **Strategic Equality Plan (SEP)** is led by the Dean of EDI/Deputy Vice-Chancellor, advised by an external EDI committee. The PVCR sits on the Equality and Diversity Committee, ensuring alignment between SEP and R&I strategy. SEP2016-2020 focused on unconscious bias, LGBT+ support, and race inequalities. R&I objectives in SEP2020-2024 include: "improving diversity of our recruitment and supporting staff to progress" and "an inclusive University culture".

A further R&I EDI group is working on: (a) diversifying research leadership; (b) EDI in translation and commercialisation; (c) Covid-19 EDI impacts (Annex). Informed by ISSF (S2.1.3), EDI information is collected for all internal funding schemes. Staff undertake mandatory online EDI and unconscious bias training, with supplementary training for managers and recruitment panels.

Cardiff's Athena Swan Bronze Award was re-accredited in 2019; 13 Schools have Athena Swan awards. Our Race Equality Steering Group is developing an action plan towards the Race Equality Charter Mark. Development Sessions for female and BAME+ Academics additionally provide support for promotions and career development. Staff networks for BAME+; Carers and Families; Enfys (LGBT+); Disability; Welsh Language; and International ensure diversity is embraced, and actively supported.

EDI metrics (professors/senior staff): 27.4% identify as female, 72.6% as male. 87.3% are UK nationals; 10.4% EU; 6% international. 87.3% of staff are white; 7.3% BAME; 5.7% not disclosed (ND). 88.7% staff note same gender at birth. Age distribution: 35-44 (12.2%); 45-54 (37.6%); 55-64 (40.6%); 65-99 (9.6%). 63.4% identify as heterosexual; 33.7% ND; 3% identify as gay, bisexual, lesbian or in another way. 22.2% staff are Christian; 19.1% have no religion; 48% ND; 0.3% Buddhist; 1% Hindu; 0.4% Jewish; 0.9% Muslim; 8% other religion/belief. Recruitment focused on early career: 16-24 (10.6%); 25-34 (46.8%); 35-44 (25.9%); 45-54 (11.7%); 55-64 (4.5%); 65+ (0.5%).

Mean gender pay-gap (T&R; T&S; R-only staff): 15.5% (median 16.5%).

3.2 Staff support and development

3.2.1 Consultation

Staff views are captured through formal and informal feedback (e.g., biennial **Staff Survey**, covering environment; decision making; career development; work-life balance). Results are analysed by School, career pathway and themes (research/education), with integrated School-College-University two-year action plans. R&I policy consultation is regularly undertaken, informed by T&R and R-only staff, as well as PGRs (S2.1). Staff recruitment is strategic, aligned to SEP2020-2024, R&I objectives, and disciplinary and interdisciplinary needs.

3.2.2 Flexible working

Flexible working policies support working hours or place of work changes. Employees can apply for career breaks (6-36 months), with the right to return on the same salary/grade. A **Returners Support Scheme** minimises the impact of extended leave by helping refresh skills, knowledge and confidence, including re-establishing research. During Covid-19, flexible working, wellbeing days and additional leave (for dependants; over Christmas) were provided, with salary and research support (£7.8m, £1m Cardiff) for PGRs and staff (including R-only, project managers and technical staff) whose research was disrupted.

3.2.3 Workload and reward

Cardiff's transparent workload model ensures equitable allocations balancing teaching, research, impact and administration; it includes research leave, external panels (e.g., REF2021), research grants, PGR supervision, impact, translational research, business secondments. T&R and T&S progression pathways are provided, including promotion for innovation and engagement. The Cardiff Academic and Cardiff Professional provide guidance for promotion, alongside support for accelerated careers. From 2019, Cardiff supported R-only staff promotion via a Senior/Principal/Professorial Research Fellow route (10 promotions, 2019). A biennial professorial reward strategy aims to ensure gender salary equity.

Celebrating Excellence Awards include Rising Stars and Excellence in Research, complementing **Innovation and Impact Awards** which celebrate staff working with non-academic partners, including ECR Future Innovators. The PVCR writes individually to staff winning research awards each month. Staff regularly win external prizes: BBSRC Innovator of the Year 2018 (*Honey*)*;* ESRC Outstanding Impact in Society Award (*Renold*); Queen's Anniversary Prizes, *Owen* (2015), *Woodhouse* (2018). Since REF2014, 79 staff became Learned Society of Wales Fellows, with *Thomas* Society President from 2020.

3.2.4 Staff development

Induction (relaunched 2019) provides tailored programmes for new staff on different pathways; research components are supported by R&I Deans. Performance Development Reviews (undertaken annually, via one-to-one line manager meetings) were enhanced (2017) to support greater reflection on R&I, aligned to School-College-University priorities.

Professorial Leadership Programme (lead: Deputy Vice-Chancellor) and Cardiff Futures (lead: Vice-Chancellor) are key leadership development programmes. Cardiff Futures involves ECR academics and professional staff working with University Executive Board members (91 staff since REF2014). The PVCR leads a dedicated R&I day, supporting attendees deliver pilot projects (e.g., ECR social networking). The University leads Welsh Crucible (an award-winning programme for research leaders: 50 Cardiff staff, 2014-2020). We partner GW4 Crucible, focused on interdisciplinary challenges (e.g., climate change: 45 Cardiff staff, 2014-2020). Cardiff is also the Wales and South West hub for the £3m UKRI Future Leaders Fellowship Development Network (*Gorrara*).

3.2.5 Wellbeing

Cardiff achieved Gold Corporate Health Standard (2015) for its health and wellbeing workplace initiatives. SEP2020-2024 emphasises wellbeing by embedding this in leadership and line manager programmes, alongside our Staff Wellbeing and Mentally Healthy University Strategy (2020). The Staff Wellbeing Group promotes our Employee Assistance Programme, a Wellbeing

programme and a Staff Wellbeing Team, who provide bespoke events. Our Dignity at Work and Study Policy (2019) notes zero-tolerance of harassment, bullying and victimisation, with Dignity and Wellbeing Contacts in every School.

3.3. ECR academics and R-only

To accelerate research ambitions, ECR academics are given reduced workloads, intensive grant funding mentoring, dedicated access to specific University R&I funding schemes (S2) and access to research leave (e.g., Disglair Lectureship Scheme, S2.1.5).

Cardiff received the HR Excellence in Research Award in recognition of our implementation of the revised Concordat to Support the Career Development of Researchers. Linked to Vitae's Researcher Development Framework, the Cardiff Researcher Programme supports R-only staff via workshops, online modules and one-to-one coaching (e.g., on grant writing, networking, research leadership; 1,735 staff since REF2014). In 2016, University-wide recommendations for ECR academics and R-only staff were agreed (aligned to R&I objectives, S1.1). The action plan is delivered by a Researcher Pathways Group (2019, lead: Dean for Research Environment and Culture), with ECR staff representation. The Cardiff University Research Staff Association (supporting R-only staff) runs an annual symposium and actively contributes to R&I decision-making (S2.1.1). New College Fellowship Development Programmes support transition to independence of R-only staff; **231 fellowships in REF2021 (versus 113 REF2014).**

3.4 Postgraduate researchers

Postgraduate Deans and School PGR Directors provide academic and pastoral support for Cardiff's PGRs, with input from College Postgraduate Forums and the Students' Union Vice-President Postgraduate. Cardiff's Doctoral Academy provides 200 workshops and training courses p.a., with the Careers and Employability team supporting skills and placements. Career destinations include education (44%), health, scientific and technical (25%), manufacturing (6%) and public (5%) sectors; mostly in Wales and England (65%). In the Postgraduate Research Experience Survey, Cardiff's supervision aligns to sector average, with professional development and research skills above average.

Our £1.3m **Vice-Chancellor's International Scholarships for Research Excellence** (2017-2019) supported 21 PGRs across 15 countries (e.g., Vietnam, Sudan, Myanmar). 14 Schools hosted China Scholarship Council PGRs, with £3.5m of University support since 2018. Our Schools funded just over 1,200 PhD studentships between 2014-2020 (stipend value £20.6m). The University contributes to 19 DTEs (e.g., £6.6m EPSRC CDT in Compound Semiconductor Manufacturing, with Manchester, Sheffield and UCL, see other examples S2.1.4). Wellbeing is supported by PGR wellbeing champions; an 'Talk Campus' app; the Health and Wellbeing Service; supervisor training; and pastoral supervisors. A confidential disclosure service and Student Advice team provide further support, alongside Dignity and Wellbeing contacts.

3.5 Undergraduate R&I experience

The **Cardiff Undergraduate Research Opportunities Programme** offers 6-8 weeks' paid research experience for undergraduates. Since REF2014, 1,140 projects were supported, across every UOA. Our new **Cardiff Innovation Development Scheme** will support undergraduates to undertake paid knowledge exchange activities. This complements our excellent **Student Enterprise** team, who facilitated 215 new student businesses since REF2014 (e.g., Yoello, a rising star mobile payment company; Phytophonics, hydroponic systems reducing carbon emissions).

3.6 REF2021 Delivery

Cardiff's REF2021 Code of Practice focused on: inclusivity; excellence; consistency; transparency and accountability. Staff delivering REF2021 had **EDI and unconscious bias training**, including Centre for Inclusive Leadership training for REF2021 decision-makers. REF EDI Group-led Equality Impact Assessments informed REF Committee decision-making. Data modelling included EDI considerations, aligned to inclusive UOA allocations. Minimum expectations for REF2021 peer review and representative reviewing teams (consistency) were implemented, with reviewer names published on the staff intranet (transparency and accountability). REF2021 updates were

communicated regularly (via email, intranet, newsletters, and Senate). Staff undertaking REF2021 work were consistently supported (REF impact team; research leave; workload allocations).

4. Income, infrastructure and facilities

4.1 Research awards and income

Multiple mechanisms and enablers (S2-4) support generation of research income, aligned to Cardiff's R&I strategy (S2). These are complemented by highly experienced and motivated professional teams (e.g., Research and Innovation Services; Strategic Planning and Governance), working in a co-ordinated and strategic way with the University Executive Board, Colleges and Schools**.**

Research awards (5,057) and income (£751m) increased considerably since REF2014 (2,772 awards; £460m income); this was seen across all Colleges (income: AHSS: +74%; BLS: +66%; PSE: +53%).

An increased focus on interdisciplinarity doubled Cardiff's Centres of Excellence: **50 in REF2021 versus 26 in REF2014.** Examples, complementing those in S2.1.4, include:

- £2m MRC Centre for Neuropsychiatric Genetics and Genomics (UOA4)

- £4.6m Centre for Artificial Intelligence, Robotics and Human-Machine Systems (UOA12)

- £5m ESRC Centre for Climate Change and Social Transformations (UOA4)

- £8m AHRC Creative Industries Cluster, Clwstwr Creadigol (UOA34)

- £15m ESRC Wales Institute of Social Economic Research and Data, with Aberystwyth, Bangor, South Wales and Swansea (UOA21/UOA23)

- £27m Cardiff University Brain Research Imaging Centre (UOA4)

- £42m Strength in Places CS Connected award, with IQE plc (UOA9/UOA12).

4.2 HEFCW investment

4.2.1 QR funding

As the leading research-intensive Welsh University, Cardiff receives approximately £40m annual HEFCW QR funding. This funding provides Schools with the financial flexibility to deliver R&I objectives (e.g., via School PhD studentships; match-funding for equipment and grants; proof-of-concept research schemes; academic, R-only and PGR research funding; professional services support).

In this REF period, School QR funding was also used to match-fund fellowships and Chair positions from the prestigious Welsh Government European Commission **Sêr Cymru Scheme**. £15.5m of external investment (£8.9m Cardiff match) supported 68 awards, in turn delivering £18m in additional grants (e.g., *Gruber*, who moved from UC Davis, obtained a £960k Wellcome Trust Henry Dale Fellowship). Sêr Cymru Chair funding supported our new **Medicines Discovery Institute (£14m),** generating a further £13m of external funding, including major Wellcome Trust and MRC DPFS awards. Since 2018, QR funding also supported a **University Strategic Research Investment Fund** (lead: PVCR)**,** designed to drive Cardiff's R&I objectives: this currently funds salary for Cardiff's UKRI Future Leader Fellows and Disglair Lecturers.

4.2.2 HEFCW RWIF

The Welsh equivalent of Higher Education Innovation Funding was reinstated in 2020-2021, having been stopped in 2013-2014. Cardiff received £2.7m for 2020-2021, with £2.7m p.a. anticipated between 2021-2023. A new Innovation Strategy (S4.4), aligned to the **Knowledge Exchange Framework Concordat**, supported investment in professional services support for impact; strategic partnerships; commercialisation; student enterprise; public engagement; civic mission, providing enhanced cross-University training and support for translational, commercial and civic mission activities. Funding was also allocated for new translational proof-of-concept schemes, expanding our successful ISSF approach (S2.1.3), and for academic-business collaborations linked to our future interdisciplinary University Innovation Institutes (e.g., compound semiconductors; crime and security; mental health, S2.1.4).

4.3 Infrastructure

4.3.1 Equipment and IT infrastructure

Since REF2014, £25m of HEFCW Higher Education Research Capital funding enabled new capital investments. Our **Research Infrastructure Fund** (£8.4m, 39 awards) supported new and refurbished equipment (e.g., mass spectrometers, microscopes, visualisation facilities and imaging platforms, see UOAs' REF5b). Investment into our £300m Innovation Campus (see S4.4.2) included a **Translational Research Hub** electron microscope suite (*Catalysis* URI) and behavioural laboratories for the **Social Sciences Research Park (SPARK)**. A further £3.5m of HEFCW world-class laboratories funding was invested in innovation priorities (e.g., cybersecurity testbed, with Airbus/Thales, UOA11), a neuro-cellular screening platform (supporting our £4m award with Japanese pharmaceutical company Takeda, UOA4), and a state-of-the-art supercomputing facility (for our *Data Innovation Research Institute*).

Cardiff's online equipment database includes 350 entries, accessible to all researchers, which feeds into both GW4, and the EPSRC's "equipment.data.ac.uk". Cardiff researchers are further supported by **Technology Hubs** (UOA5) and **Cardiff's Central Biotechnology Services,** the latter hosting shared cell analysis, genomics, and diagnostics equipment. GW4 provides additional specialised equipment (e.g., electron cryo-microscopy) and archives (GW4 Treasures), as well as funding cross-University networks to support new research collaborations (many led by Cardiff academics).

Cardiff's IT department (~£20m p.a.) provides institution-wide R&I, learning and teaching support. A dedicated research datastore supports large data projects, with robust information handling and protection procedures. A Cardiff open-data repository enables data sharing, with a new upgraded service (based on Jisc's Research Repository) launching mid-2021. **Advanced Research Computing@Cardiff (ARCCA)** provides leadership and support for complex computational research projects, and, through GW4, co-delivers the ESPRC-funded Isambard, providing access to accelerator technology and early release infrastructure in collaboration with blue chip companies. Cardiff leads **Supercomputing Wales**, a £16m pan-Wales collaboration (with Aberystwyth; Bangor; Swansea), with an enterprise supercomputer, data analytics platform and scalable storage infrastructure. These investments saw a **six-fold increase in Cardiff's computational capability** since REF2014, complemented by investment in software engineers to help researchers exploit these unique facilities.

4.3.2 University Libraries

Our libraries have 1.1m physical items, 100k journals and nearly 1m e-books (across 11 libraries and online). £3.9m is spent on journal subscriptions, with 8.5m digital downloads in 2019-2020. Special Collections and Archives **(100k print items, 2km of archives, 500 artworks, worth £10m)** cover unique 15th Century rare books to born-digital collections and support interdisciplinary research on Welsh and global culture, language, humanities and history. Key partners include: Research Libraries UK; JSTOR's Open Community Collections; Archives Wales; Association of Research Libraries; GW4. **Partnership with the National Library of Wales** provides onsite access to 16m Non-Print Legal Deposit e-books, journal articles and websites. Grants (£50k) in the REF period included: The National Archives; National Manuscripts Conservation Trust; The Learned Society of Wales, Literature of Wales; and Archives and Records Council Wales. Cardiff is in the **top 20 of 351 UK institutions sharing content on Archives Hub**.

4.4 Innovation and impact

4.4.1 Commercialisation

Cardiff's Commercial Development Team provides commercial and entrepreneurship training and funding, and supports IP protection, patents and new companies. The team also leads our **Innovation Incubators** (S4.4.3) and works closely with Student Enterprise (S3.5). **Cardiff ranks 1st in Wales for IP income, accounting for 81% of IP in Welsh Universities since REF2014**, with income totalling £22.7m (e.g., *Finlay's* Dermatology Quality of Life Index; *Cooper's* Human Gene Mutation Database, UOA1 impact cases). Cardiff further attracts investment from public and

private sector (£147m since REF2014), including via ASPECT, which supports commercial opportunities in the social sciences.

MRC Confidence in Concept and **Proximity to Discovery funding** (total £2.7m) supported 80 projects (e.g., Jones' £45k project on DNA therapies in Huntington's disease, which subsequently obtained £1.5m of external funding, including from spin-out company LoQus23 Therapeutics). Translational income (e.g., from MRC DPFS) increased almost four-fold (£2.7m in 2013-2014 to £9.9m in 2019-2020). **Cardiff holds 3rd place** (for the 2nd consecutive year) on the Octopus Ventures *Spinning out Success: Entrepreneurial Impact Ranking 2020;* this measures generation of sustainable businesses, based on research income and the exit value of spin-out companies.

4.4.2 Building up innovation

Cardiff's **£300m Innovation Campus** is the physical heart of our innovation activities, supporting delivery of our Innovation for All strategy. The campus facilitates economic growth, advances academic-business partnerships, knowledge exchange and commercialisation, and delivers innovation-led career opportunities for Cardiff's skilled graduates. Flagship buildings since REF2014 include:

- **Hadyn Ellis Building** (£30m): home to the *Neuroscience and Mental Health Research* URI; *European Cancer Stem Cell Research* URI; UK Dementia Research Institute Centre; and hub for our £4m drug discovery collaboration with Japanese company Takeda.

- **CUBRIC** (£44m): one of Europe's leading interdisciplinary brain imaging centres, delivered in partnership with Siemens, funded via £27m of Wellcome Trust, UKRI and European investment.

- **SPARK** (£56.5m, opening Autumn 2021): the world's first social science research park focused on children and young people, wellbeing, sustainability, artificial intelligence, public service delivery and foundational economy. Including Office for National Statistics and civil society organisations, SPARK will co-locate with our **Innovation Centre**, supporting spin-outs, licensing, knowledge exchange and impact.

- **Translational Research Hub** (£131m, opening May 2022): academic-business space for *Catalysis* URI and *Cardiff's Institute for Compound Semiconductors,* focused on growing industrial collaboration with companies (e.g., IQE plc; Newport Wafer Fab; BP).

These were complemented by investment in:

- £10.3m state-of-the art building for our School of Journalism, Media and Culture (No 2. Central Square), located adjacent to BBC Cymru; this is closely interconnected with **Clwstwr Creadigol's** Cardiff City Hall base, with both supporting acceleration of Cardiff's screen sector innovation.

- £39m **Abacws** building (opening Autumn 2021), for the Schools of Mathematics and Computer Science and Informatics, including laboratories to advance cybersecurity research and expand Cardiff's £3.5m **Data Innovation Accelerator** (supporting SMEs (e.g., Sustainable Energy Ltd.; W2 Global Data Ltd.) to utilise data to drive business objectives).

4.4.3 External partnerships

Our **Cardiff University Innovation Network** includes 1,800 members (e.g., Welsh anchor companies; local SMEs; Welsh Government; local councils) and supports private and public sector collaboration. A new joint **Clinical Research Office with NHS Wales**, an integrated **Clinical Trials Research Unit**, and **Medicentre***,* a Cardiff-NHS innovation incubator for new Biotech and medtech start-ups, helped advance biomedical and clinical collaborations across Wales, as well as across the UK. For example, Cellesce Ltd, a UOA5 spin-out company, is based in Medicentre (impact case). **ACCELERATE**, led by the Life Sciences Hub Wales, involves Cardiff, Swansea and University of Wales Trinity Saint David: this £24m initiative supports entrepreneurs developing new NHS health products, diagnostics and services.

Strategic Partnerships support Cardiff's R&I strategic objectives, ensuring our research delivers aligned to the business and public sector needs of Wales and the UK. Our successful partnership with the Office for National Statistics' Data Science Campus facilitates R&I in our *Data Innovation Research Institute* and supports our **Data Science and Software Academies** (which, via applied degrees with business, address the shortage of Welsh data scientists, programmers and software engineers). A new £10m Challenge Fund (launched in 2021) involving Cardiff Capital Region and Y Lab further supports local authorities and other public sector organisations to use data for effective policy and practice interventions, aligned to **SPARK's** future R&I ambitions. These examples exemplify how academic-business-public sector collaborations, aligned to the interdisciplinary R&I entities on our £300m Innovation Campus, provide the exciting foundation for Cardiff to continue to be a vital enabler of positive societal change in Wales, the UK and the world.