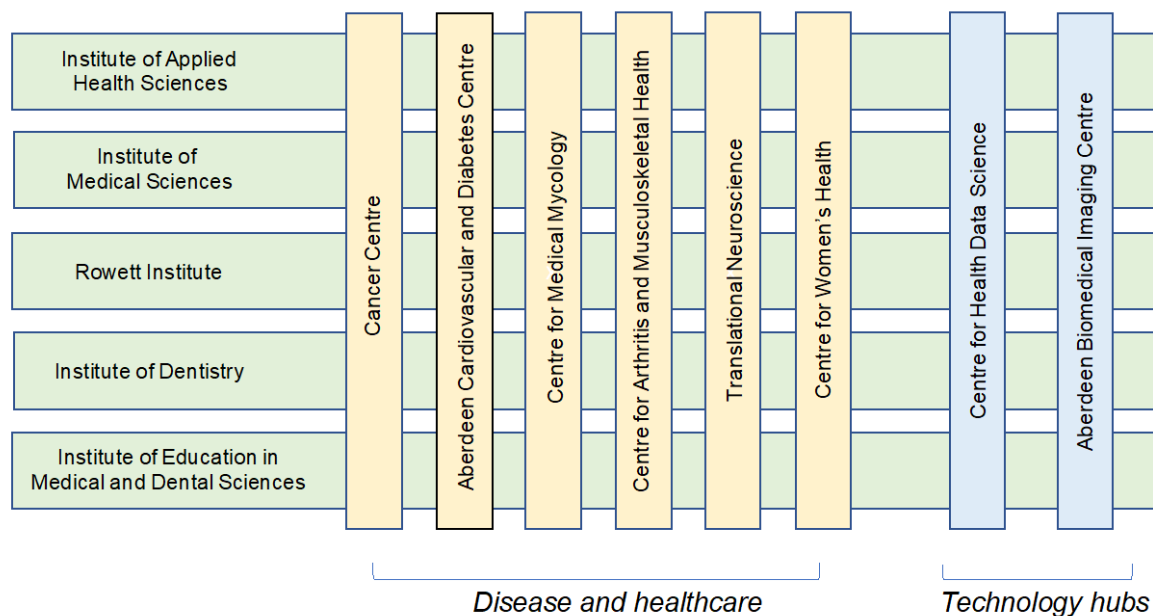


Institution: University of Aberdeen
Unit of Assessment: 1 (Clinical Medicine)
<p>1. Unit context and structure, research and impact strategy</p> <p>A: UoA1 OVERVIEW:</p> <p>Advancing translational medicine across a range of complex clinical challenges is the primary objective of the University of Aberdeen's 140-researcher Unit of Assessment 1 (UoA1) <i>Clinical Medicine</i>. It has the necessary integration of clinical and medical science research to deliver improved care at the hospital bedside, with multidisciplinary expertise spanning bench medical sciences through to applied health sciences. Drawn from the University of Aberdeen's School of <i>Medicine, Medical Sciences and Nutrition (the School)</i>, with its long history of medicine and medical research, UoA1 researchers are co-located with the NHS Grampian Acute Sector hospitals at one of the largest healthcare sites in Europe - the Foresterhill Health Campus. This vibrant research environment, defined by integrated teams of bench scientists, clinical academics and clinicians, provides an exemplary pathway for catalysis of medical science discovery and its translation.</p> <p>The dynamic translation of research into clinical practice is achieved through close School/UoA1 partnership working with the NHS. The shared (NHS/UoA) sponsorship of major research projects includes clinical trials and shared clinical academic spaces involving University-led delivery of clinical services including imaging and IVF; these embed research within day-to-day clinical services. Together with our shared Data Safe Haven (DaSH) for governance of clinical data for research and public health, these elements are part of the unique environment within which translational medicine flourishes. The collaborative development of the Foresterhill Healthcare Campus has seen a new-build University GBP40,000,000 nutritional sciences research institute, and a University-funded GBP1,900,000 project will shortly build a first-of-kind Fast Field-Cycling MRI within the hospital estate for research clinical trials. On the same site, a planned GBP40,000,000 <i>BioHub</i> lifescience incubator will catalyse healthcare innovation.</p> <p>The integration of our health science research with the clinical work of the NHS Grampian hospitals has, for example, directly led to what is nationally one of the largest collections of clinical trials running concurrently in benign gynaecology and urology (GBP5,000,000) and has driven a range of impacts in medicine. Examples include: chronic pain management, fertility modelling, advances in understanding of medicines safety (Primodos); and in nutrition, microbiological food safety and nutrition in weight management. The integration of our distinct research and methodological strands is aimed at (i) understanding the mechanism of disease, such as, the causes and consequences of different conditions and (ii) developing effective treatments and ways of delivering patient care; in these ways, we deliver healthcare transformations to the communities we serve.</p> <p>Our communities further benefit from UoA1's focus on industrial engagement, a strong contributor to our region's future economic success. The economic impact arising from UoA1 spin-outs was a key factor justifying the infrastructure investment in life sciences (for the <i>BioHub</i> incubator) from the Aberdeen Region City Deal (ACRD). This ongoing collaborative effort is part of a wider strategy to grow a life science industry to drive economic diversification in the North East of Scotland. Through UoA1's spin-out company generation, and a clear impact strategy set in the context of our healthcare environment, UoA1 research is leading to the development of new medicines and medical devices, including Elasmogen (next generation immuno-therapeutics), TauRX (Alzheimer's Disease therapeutic) and Sirakoss (bone implant devices for orthopaedic surgery).</p> <p>A structure to enable delivery of our mission</p> <p>The School is organised into five institutes, with UoA1 staff primarily located in the three most research-intensive of these; the Institute of Medical Sciences, focused on biomedical and translational medicine research; the Rowett Institute, one of only two specialist nutritional</p>

research institutes in the UK; and the Institute of Applied Health Sciences, comprising applied health and epidemiology researchers. The 140 researchers who were in 2014 organised and assessed across UoA 1, UoA2 and UoA5 are now a single UoA1 *Clinical Medicine* Unit. This enhanced research coherence is expressly designed to deliver healthcare insight and impact across preventive medicine and public health. The School’s health services researchers with methodological focus (30 FTE) are being submitted separately in UoA2, with small numbers also to UoA5 (5) and UoA23 (2.4). The impact of our interdisciplinary research and its translation extends beyond UoA1, underpinning impact case studies presented in UoAs 8, 11 and 18.

Our strategy is underpinned by thematic organisation of research into cross-cutting, healthcare challenge Centres, using disciplinary expertise drawn from across our Institutes (Figure 1). The disease-themed Centres focus on cancer, arthritis and musculoskeletal health, medical mycology, cardiovascular disease and diabetes, translational neuroscience and women’s health. These six Centres are supported by two more methodology-focused Centres in Data Science and Imaging. The final research focus, nutritional science, is already thematically organised within the Rowett Institute. In section B, we describe the unique strengths of each grouping, and how each delivers key translational medicine impacts.

Figure 1: Unit of Assessment 1- Institutes and cross-cutting Centres



B: DISEASE AND HEALTHCARE FOCI

B1: Cancer

The *Aberdeen Cancer Centre* (led by **Speirs**) integrates cancer expertise from cell biological to health data science, focused on breast, prostate and colorectal cancer. Its unique strengths are defined by its integration with the School’s health data science expertise (**Anderson, Black-C.**) and novel imaging technologies (Fast Field-Cycling [FFC]; **Lurie, Broche**), together representing a significant translational medicine advantage. The Centre was formed in 2017 as part of a GBP4,500,000 partnership investment by NHS-Grampian, the University of Aberdeen and the charity Friends of Anchor. **Speirs’** appointment has already been strengthened by the appointment of **Anderson**, a cancer epidemiologist in the Centre for Health Data Science, in the context of the 2023 opening of a GBP163,000,000, Scottish Government-funded, NHS cancer centre on the Foresterhill Health Campus.

Cancer biology: **Speirs** is investigating key differences between the biology of male and female breast cancer and is collaborating with NHS breast cancer surgeons **Elsberger** and **Masannat**. Clinical academic pathologist **Murray-G.** has shown how digital pathology and immunohistochemistry can be used in colorectal cancer stratification of patients for enhanced treatment options. **McEwan** is researching a new class of androgen receptor-targeting molecule to treat recalcitrant castrate-resistant prostate cancers (MRC, Prostate Cancer Research Centre GBP1,500,000 combined). Through a GBP800,000 CRUK Programme grant, **Donaldson** is investigating the role of the DNA replication factor Rif1 in tumour cell survival, through its effects on chromosome stability (PMID: 31141682) with Early Career Researchers (ECRs) **Kubota** (GBP970,000 MRC Fellowship) and **Hiraga**, now appointed to Lecturer and Senior Lecturer positions. Clinical appointment **Ramsay** adds expertise on genome stability in colorectal cancer. The focus on genome biology is complemented by **Hu** (DNA condensation) and **Lorenz** (meiotic recombination).

Diagnosis, prevention and treatment of cancer in primary care: Research on the HPV vaccination (**Cruickshank** PMID: 28965955) has quantified reductions in HPV incidence, informing the cervical screening programme structure and cost-effectiveness models. **Murchie's** primary healthcare research on cancer referrals is complemented by analyses of differences in diagnosis and treatment of rare cancers that comprise 25% of the population burden (**Anderson**). **Miedzybrodzka's** clinical genetics expertise has revealed stratification of oesophageal cancer responses to gefitinib (PMID: 28537764). The Aberdeen Cancer Centre is closely linked to breast cancer surgery in the adjacent Aberdeen Royal Infirmary; NHS breast surgeon **Masannat (NRS Career Research Fellow)** is working with **Lurie** and **Broche** on novel cancer imaging technologies, with the potential to transform diagnosis and patient stratification; and **Elsberger (NRS Fellow)** is piloting the launch of a Scottish Breast Cancer Genetic Mutation Database with **Speirs** and **Miedzybrodzka**, showing the strength of the shared University-NHS Foresterhill health campus.

Examples of impacts arising:

1. **Cruickshank's** work on HPV vaccination revealed the remarkable efficacy of the bivalent HPV vaccine (PMID: 28965955; 2019 top-100 Altmetric scores), leading to her WHO consultancy on European vaccination programmes, cited in WHO document "*Global strategy towards eliminating cervical cancer as a public health problem*".
2. The University of Aberdeen is an Innovate UK-funded (GBP660,000) member of **iCAIRD** (GBP10,000,000), a national network of four universities, Canon Medical Research (radiology) and Royal Philips (digital pathology), with the Centre for Health Data Science (CHDC) leading Aberdeen's expertise in developing AI innovation in radiology and pathology. Working within the iCAIRD framework and the University's Data Safe Haven (DaSH), NHS consultant radiologist, **Lip**, is clinically evaluating artificial intelligence algorithm (AI) analysis of mammography images for breast cancer diagnosis.
3. The University's biologics-based spin-out **Elasmogen (Porter, UoA1)** is developing shark antibody-derived (VNARs) from its patent-protected library of 100 billion clones. In collaboration with Almac Discovery Ltd, antibodies targeting the marker *ROR1* for cancer treatment are being developed (entering pre-clinical development in 2021). With **McEwan**, Elasmogen is developing engineered antibodies to target the androgen receptor in prostate cancer.

B2: Cardiovascular Disease and Diabetes

The *Aberdeen Cardiovascular and Diabetes Centre* (Aberdeen CDC) has linked its clinical and molecular cardiovascular research with the Rowett Institute's expertise in understanding of satiety and metabolic regulation signals, creating a unique combination of strengths. The Centre has a clear impact focus on cardiovascular disease including stroke, diabetes treatment and neurological control of energy metabolism and satiety.

The diagnosis and treatment of heart attack and stroke are two key Centre foci; **Dawson** is an academic cardiologist investigating the role of mitochondrial function in heart disease and

Takotsubo cardiomyopathy (TC-M). Funded by a total of GBP770,000 British Heart Foundation (BHF) grants, she is working with immunologist **Wilson H.**, demonstrating that TC-M aftermath is associated with a number of inflammatory signals and cytokine disturbance (PMID: 30586731).

Macleod's stroke management research (PMID: 31970577), including service organisation and secondary prevention, is complemented by her use of a unique clinical imaging instrument, the magnetic resonance Fast Field-Cycling developed by **Lurie** and colleagues, to image and diagnose stroke and small vessel disease. The understanding of blood clotting processes underpinning stroke is a focus of **Mutch**.

Pursuing the development of new treatments, **Mody** and **Thompson-D** are investigating the use of the vitamin A-like drug fenretinide to counter type 2 diabetes. The **Delibegovic** group, funded by a total of GBP740,000 BHF, and a GBP600,000 grant from Cohen Global Pharmaceuticals has shown the inhibitory effect of the anti-cancer drug trodusquemine on heart disease-associated protein tyrosine phosphatase, acting to decrease atherosclerotic plaque size.

Hoppler (GBP1,100,000 BHF programme grant) is using model systems and stem cell culture to understand cardiac tissue repair responses following infarction.

Examples of impacts arising:

1. **Dawson:** the establishment of the largest global registry of Takotsubo cardiomyopathy cases has led to communication with eDRIS to establish a Scottish, takotsubo disease code leading to a new correspondent code in the International Classification of Disease registry ICD11 (BC43.5 Stress-induced cardiomyopathy), facilitating collation of cases and patient metadata for studies of this condition.
2. **Lurie** is constructing the next-generation, patient-ready, prototype of his group's world-first Fast Field-Cycling (FFC) MRI instrument, a step-change in magnetic resonance imaging (MRI) technology. FFC uses a switched magnetic field strength during the collection of MR images, gaining access to radically new types of endogenous tissues contrast at a lower magnetic field strength compared to current clinical MRIs. The next generation instrument, sited within the Royal Infirmary complex and itself co-located with clinical MRIs, will allow cohorts of patients to directly transfer into the FFC facility for tests of its imaging capabilities across a range of clinical conditions including stroke and cardiology. The current prototype is already being used for brain imaging for stroke patients (**Macleod** PMID: 31320653) and a cardiac FFC MRI study (**Dawson**).

B3: Medical Mycology

The *Centre for Medical Mycology* was established to capitalise on world-leading understanding of the cell wall of fungal pathogens and their recognition by the innate immune system. The integration of these two fields of study within one Centre makes a genuinely transformational insight into immune recognition of pathogens possible. Recognised by the award of a GBP2,820,000 MRC Centre grant in 2016, it is backed by GBP2,300,000 of University of Aberdeen and School support for Early Career Researcher posts and PhD studentships.

Over the REF review period, the Centre was underpinned by a GBP5,100,000 Wellcome Trust Strategic Award (WTSA: 2012-2020) awarded to **Gow**, in partnership with Radboud University, Netherlands. The WTSA created a Medical Mycology and Fungal Mycology Consortium, linking Imperial College and KCL, London and six other UK universities. Following this, **Gow** (GBP2,750,000; 2013-18) and **Brown-G** (GBP2,200,000; 2014-19), secured Wellcome Trust Senior Investigator Awards, and **Brown-A** was awarded an MRC Programme grant (GBP1,980,000; 2016).

The Centre's investigation of fungal cell-immune system interactions has made a series of major contributions to understanding in this area, including: identification of a melanin-sensing C-type lectin as an essential component of antifungal immunological resistance; the regulation of β -glucan masking and immune evasion by fungal pathogen carbon source (**Brown-A.**, with ECRs **Childers** and **Ballou**); the cell wall shielding of immunogenic epitopes from the immune system

in *Cryptococcus* (**Munro, Gow**); and “rewiring” of ubiquitination targets that govern *Candida* pathogenesis (**Maccallum** and **Brown-A.**, with ECRs **Childers** and **Ballou**).

The establishment, capacity building and maturation of the *Centre for Medical Mycology* over the review period are a testament to the environmental support that the School provides to foster excellence and the Centre development process. In 2018, after Gow secured a senior leadership position at the University of Exeter as Deputy Vice-Chancellor, the MRC Centre funding transferred to Exeter. A strong nucleus of PIs with fungal pathogenesis expertise continue to drive research in this area, including a focus on the molecular mechanisms of antifungal drug resistance (**Munro, Maccallum, Childers, Lorenz, Rudkin**).

Examples of impacts arising:

1. **Brown-G.** developed new understanding of the fungal-infection condition *Chromoblastomycosis*, affecting LMIC rural populations in South America. **Brown-G.** discovered that Toll-like (TLR) receptor immunity fails in chromoblastomycosis but can be restored by exogenous administration of TLR agonists (PMID: 24633683). This therapy was successfully tested in four patients using the FDA-approved topical TLR agonist (Imiquimod), with all showing clinical improvements.
2. Award-winning (Converge Challenge 2019) Early Career Research, **Rudkin’s** research on human B cell-derived anti-*Candida* antibodies as a therapy for resistant fungal disease, (PMID: 30538246) underpins the new spin-out *mycoBiologics*.

B4: Arthritis and Musculoskeletal Health

The *Aberdeen Centre for Arthritis and Musculoskeletal Health* is unique in combining expertise in clinical biomedical science, epidemiology and health services research. This, along with the novel medical device spin-out company Sirakoss (detailed in the following section), forms a highly impact-driven portfolio that focuses on inflammatory arthritis and common musculoskeletal conditions that give rise to chronic pain. The Centre is designated a European League Against Rheumatism (*EULAR*) Centre of Excellence in Rheumatology (one of 22 such centres across Europe). Research across the Centre is structured into three main areas:

Arthritis and Regenerative Medicine Laboratory; Research by **de Bari** and **Roelofs** is seeking to understand how stem cells and stromal connective tissue in the joint function in arthritis pathogenesis and joint repair (*Arthritis Research UK [ARUK]* GBP1,130,000; MRC: GBP500,000). Their research has now identified the proteoglycan *agrin* as a potent restoration factor for the bone-cartilage interface, with significant clinical translation potential for cartilage repair (PMID: 32878982). The Centre is also funded by Samumed, investigating the joint regeneration potential of the disease-modifying osteoarthritis drug (DMOAD) SM04690, currently in osteoarthritis clinical trials.

The *Epidemiology Group* focuses on the epidemiology and modifiable risk factors of arthritis and musculoskeletal pain conditions (e.g., fibromyalgia) to inform clinical trials of therapies with the aim of improving patient outcomes. The group manages two important national databases, the British Society of Rheumatology (BSR) Biologics Register in Ankylosing Spondylitis (BSRBR-AS) (GBP970,000; **Macfarlane**) and the BSR register in Psoriatic Arthritis, funded by BSR (GBP1,000,000; **Jones**). The Epidemiology group leads research in occupational outcomes for people with arthritis and musculoskeletal diseases as part of the distributed MRC and *Versus Arthritis* Centre (hub at the University of Southampton; GBP550,000 for the Aberdeen “spoke”; **Macfarlane**). **Macfarlane** and **Jones** are conducting the Arthritis Research UK-funded MAMmOTH trial (GBP1,000,000), with the aim of preventing the onset of chronic widespread pain, having previously been the first to demonstrate a link between chronic pain and mortality.

The *Biomaterials and Bone Regeneration group* is developing the now clinically licenced novel hydroxyapatite scaffolds for use in orthopaedic surgery, whose technology is developed by spin-out *Sirakoss* (Gibson; UoA 8 *Chemistry*) acquired by OssDsign in 2020.

Examples of impacts arising:

1. **Gibson's** bone graft substitute technology, a hydroxyapatite-based material applied during bone surgery to promote new bone growth (US Patent no. 8,545,895), received 2019 regulatory approval in Europe and USA, with clinical use commencing in 2020. Sirakoss has secured venture capital (GBP4,000,000) and Innovate-UK grants (total ~GBP2,000,000) since 2014, and in 2020 was acquired by OssDesign for GBP8,400,000 (forming an Impact Case study as part of this submission).
2. **Greig** has developed a first-in-class anti-inflammatory drug invented and developed at the University of Aberdeen (PMID: 20692834; Granted patent application: WO2010/032009). Since 2014, the spin-out company, OsteoRx's licensing partner completed Phase 1, and 2a clinical trials have secured investment of GBP12,400,000 for the clinical development and subsequently a GBP176,000,000 licensing option with Johnson and Johnson.
3. **Jones**, McNamee, **Macfarlane** and **Hannaford** have generated impact through their research on chronic pain, affecting approximately 20% of the population. They established the burden of chronic pain in Scotland, prompting the Scottish Government's decision to provide new funding of GBP1,300,000 to Scottish Health Boards to develop the Scottish Service Model for Chronic Pain (forming an Impact Case study as part of this submission).

B5: Nutritional Sciences

The *Rowett Institute* is one of only two research institutes in the UK carrying out mechanistic research in nutrition and is Scottish government-funded to deliver impact-driven nutritional science research (5-year, GBP37,500,000 RESAS programme). Director **Morgan-P** is leading a programme of fundamental and impact-driven human nutrition research that aligns closely with the *Healthcare and Nutrition* element of the University's *Aberdeen 2040* strategy. The Rowett's research coherence is organised around *Obesity and food choice*; *Gut Health*; *Metabolic Health*; and *Life-course Nutrition* and has multiple collaborative links with the Aberdeen Cardiovascular and Diabetes Centre and Translational Neuroscience.

Obesity and food choice; **Heisler** and **Gonzalez Sanchez** (aligned with the *Aberdeen Cardiovascular and Diabetes Centre* [B2], and Translational Neuroscience [B7]) are using advanced optogenetics to identify the neural circuits underpinning glucose homeostasis and hypoglycaemia responses and appetite regulation (PMID: 25470549; PMID: 26974347), and with **d'Agostino**, (MRC Research Fellow; GBP960,000) the potential of the anti-obesity drug lorcaserin to counter type-2 diabetes. Two other recent appointments, **Sylantsev** and **Naneix**, with expertise in neural mechanisms of food choice have further strengthened this unit. With a focus on dietary intake, **Johnstone** is working with **Barrett** and **Mercer** to understand how protein-rich diets can control satiety, linking directly to impact; Johnstone has funding from food producers (Tate and Lyle; GBP390,000) and retailers (M&S; GBP200,000) investigating dietary composition on satiety.

Gut Health: **Louis** and **Flint** focus on the complexities of microbiome composition and role in gut health and have secured industrial funding to investigate key microbiome species for use as dietary probiotics. **Walker** has expertise in metagenomic analysis of microbiome composition and is collaborating with **Haggarty** on the GBP18,200,000 MRC GCRF-funded *Action Against Stunting Research Hub*, to investigate the role of the microbiome in childhood growth slowing. The *Metabolic Health* research group is conducting human dietary intervention studies focusing on links between diet and microbiome composition (**Drew**, **Walker**, **Flint**) and cardio-metabolic health outcomes in human intervention studies (**de Roos**, **Thies**), for example using randomised human intervention trials to assess the effects on volunteer blood omega-3 levels of consuming farmed salmon reared on different oils (PMID: 33015732). *Lifecourse Nutrition* forms the final research focus with a significant focus on the UN Sustainable Development Goals SDG2 and 3;

Russell is funded by a BBSRC GCRF grant (GBP450,000) informing the use of moringa as a sustainable food source in Malawi.

Examples of impacts arising:

1. **Supermarket retailing of protein-rich foods for calorie control diets:** **Johnstone's** research into the satiety-inducing effects of protein-rich diets (PMID: 28687371) has informed the development of Marks and Spencer's highly successful "Balanced For You" health food brand, which enables consumers UK-wide to manage body weight as part of a healthy diet (ICS).

B6: Women's Health

The Centre for Women's Health's (CWH) research adopts a life-course approach to women's health, studying causes and consequences of common reproductive problems in women, the effectiveness of clinical interventions and the best way of delivering person-centred care. Integrated with NHS Grampian's assisted reproduction unit, it draws on UoA1's unique combination of strengths in reproductive physiology, nutrition and epigenetics, as well as epidemiology and innovative approaches to evidence synthesis, randomised clinical trials and prediction modelling.

Fertility and infertility; **Bhattacharya-Si's**, research evaluates the effectiveness of fertility treatments including intracytoplasmic sperm injection (ICSI) and PICSI modifications. Further NIHR-funded research is investigating embryo-freezing protocols in IVF (**Bhattacharya-Si**, GBP930,000). Recent appointment, Mol, has a mature portfolio of global randomised trials in infertility, revealing that a lifestyle intervention did not improve the chance of having a vaginal birth of a healthy child, and that frozen embryo transfer in IVF was as effective as fresh embryo transfer. Collaboration between them and their respective research groups since 2014 has led to a series of projects on a personalised approach to fertility treatment involving the use of novel prediction tools.

Pregnancy and childbirth; **Fowler** leads research in the role of endocrine disruptors on foetal development (EU GBP600,000), including effects of maternal smoking and obesity on foetal thyroid and endocrine function. **Vargesson's** research has revealed the teratogenic effects of the drug Primodos in model organisms, leading to impacts on medicine safety enquiries (see *Impacts, below*). **Bhattacharya-So**, has investigated the optimum interpregnancy interval following pregnancy loss, informing women wishing to conceive following miscarriage (see *Impacts, below*). **Black-M.**, is using national data to investigate the consequences of different modes of birth including the associations between caesarean birth and childhood health.

Menstrual bleeding and endometriosis: **Bhattacharya-Si** leads a programme of research in menstrual disorders, which has attracted over GBP6 million from NIHR HTA in the current REF cycle (Trials : Preempt, HEALTH, Diamond, Regal) revealing that laparoscopic supracervical hysterectomy is more effective than endometrial ablation in women with heavy menstrual bleeding (HEALTH trial; PMID: 31522846).

Abdel Fattah leads research in pelvic floor disorders and continence including the management of female stress urinary incontinence and pelvic organ prolapse, covering a GBP5,250,000 portfolio of NIHR HTA surgical trials, one of the largest trial portfolios in urogynaecology nationally (SIMS, FUTURE, Catheter II).

Examples of impacts arising:

1. **Vargesson's** research into the effects of the 1970s pregnancy test Primodos on embryo development showed induced developmental abnormalities in zebrafish embryos (PMID:

19433787; PMID: 29440757). This informed a major UK independent public inquiry into Primodos, which in July 2020 concluded that “*children suffered ‘avoidable harm’ from failure to regulate [Primodos]*”. His expert opinion on Thalidomide teratogenesis has supported medical litigation cases in Italy, Australia and Canada. (both ICSs).

2. **Bhattacharya-So**'s evidence-based meta-analysis of over 1m pregnancy records has revealed inter-pregnancy intervals (IPI) after an initial miscarriage do not affect subsequent conception chances, forming the basis of altered patient advice in multiple clinical and charity advice sources (PMID: 20688842).
3. **Bhattacharya Si** and McLernon's research (PMID: 27852632) used the UK Human Fertilisation and Embryology Authority (HFEA) database to demonstrate that the chances of IVF success stabilise after three cycles, meaning that further cycles may not be worthwhile for most couples. Their resulting probabilistic model is now online (<https://w3.abdn.ac.uk/clsm/opis/>) and available to any parents seeking to conceive *via* IVF. This has informed clinical reasoning and a policy change on IVF funded cycles by NHS Scotland. The research informs patient and clinician decision-making internationally, with the prediction model web tool delivered on the web site of the USA *Society for Assisted Reproduction Technology*, the primary professional organisation for assisted reproduction in the US (<https://www.sart.org/>).

B7: Translational Neuroscience

Translational neuroscience is a nascent centre, focused on a range of neuro-degenerative conditions, from Alzheimer's Disease (AD) to Spinal Muscular Atrophy. This focus is complemented by research on the role of stem cells in neuro-regeneration and on AD chemotherapy, which is driving a number of important research impacts.

Platt and **Riedel**'s research into *neurodegenerative* disease focuses on the role of pre-fibrillar tau with β -amyloid in AD pathology. This aligns well with the objectives of spin-out **TauRX**, where **Wischnik** and **Harrington** (CEO, CSO) are developing new AD pharmaceuticals, collaborating with colleagues in UoA8, where the compounds are currently in several Phase 3 clinical trials. **Parson**'s research on Spinal Muscular Atrophy (SMA) is focused on understanding its causal mechanisms, showing that Spinal Muscular Atrophy (SMA) causes vascular defects and spinal cord hypoxia (PMID: 26506088). *Neuro-development and neurogenesis* by adult stem cell progenitors is being investigated by **Berg**, revealing that in the mammalian brain, adult neural progenitors have an embryonic origin (PMID: 30929900). **Erskine** has uncovered new retinal connections between vertebrate eyes, essential for axonal guidance during development (PMID: 30905607). **Kang** is using stem cell-derived brain organoids, developed from patients with mental illness, to better understand their molecular mechanisms. **Huang** is studying the regulation of neurite outgrowth in spinal cord injury models.

Neuroimaging is another significant focus. In an interdisciplinary team with physicist colleagues, **Platt** is using EEG as a novel imaging tool, able to time-, frequency- and direction-resolve communication within brain networks with potential for diagnosing delirium patients in ICU (PMID: 32455162). **Lurie** and **Broche** secured GBP1,030,000 EU funding to develop the first patient-capable FFC, an extension of MRI technology with unique imaging potential, now used to image the brain of stroke patients with **Macleod** (CSO; GBP300,000) and cardiac FFC MRI with **Dawson** (BHF; GBP280,000). ECR **Vuksanovic** and **Wischnik** are now using MRI to diagnostically resolve Alzheimer's disease (AD) and the related behavioural variant Fronto-Temporal Dementia (bvFTD).

Examples of impacts arising:

1. **Wischnik** is Chief Executive of **TauRx Pharmaceuticals**, a University spin-out. With **Harrington**, TauRx is conducting phase 3 clinical trials of Alzheimer Disease treatment hydromethylthionine. TauRX has secured over USD300,000,000 investment since 2014 and now funds a 68-scientist team at the University (ICS).

2. **Saccade Diagnostics** is a University of Aberdeen spin-out launched by **St Clair**. His research (PMID: 16860975) has identified a novel screen for psychiatric disorders by recording unconscious saccadic eye movements. Software analysis of these can distinguish schizophrenia from controls with a sensitivity of around 95%. This represents the first technology-based diagnostic tool in psychiatry. A GBP1,400,000 Department of Health/Wellcome Trust award to Saccade Diagnostics Ltd is being used to validate the technology.
3. Keenan, working with **Miedzybrodska**, has developed support and mentorship tools for young people in families internationally, where an adult has Huntington's Disease, to address the emotional stress caused by a parental diagnosis that has a 50% chance of affecting the young person in later life (ICS).

B8: Data Science and Imaging

The Centre for Healthcare Data Science (CHDS):

The complexity of medical diagnosis, and of patient life-course journeys, creates large amounts of healthcare data with huge research potential. The Centre for Healthcare Data Science (CHDS), led by **Black-C.** and with the strategic appointment of **Anderson**, is using health data sciences to lead research on kidney disease, arthritis and stroke. CHDS provides key methodological support to research centres such as: a data linkage work package within the GBP800,000 Versus Arthritis-funded PACFiND study, designing care pathways for people with fibromyalgia; and the Nuffield Foundation funded study Rheumapps, examining care pathways for musculoskeletal conditions (*Centre for Arthritis and Musculoskeletal Health*-linked). Additionally, methods are being evaluated to better target care for breast cancer patients and other conditions (*Aberdeen Cancer Centre*-linked). In partnership with NHS Grampian, the CHDS operates the *Grampian Data Safe Haven* (DaSH), ISO 27001:2013 accredited for safe governance of NHS healthcare data and one of only five such safe havens in Scotland. In 2015 it became a signatory of the *Charter for Safe Havens in Scotland*. These resources have been centrally important to NHS-Grampian as it responds to the Covid-19 pandemic. Established, led and managed by Aberdeen, but available for global research, the Centre is the custodian of unique database assets including the Aberdeen Children of the Nineteen Fifties birth cohort (six publications over the review period) and the Aberdeen Maternity and Neonatal Databank, comprising all reproductive events in Aberdeen from 1958 (24 publications).

The Aberdeen Biomedical Imaging Centre (ABIC):

ABIC is a combined research and clinical imaging unit which includes preclinical and clinical MRI, preclinical and clinical PET CT, cyclotron and radiochemistry laboratories. The Centre has close links with a number of the Centres in UoA1 including Translational Neuroscience, Cardiovascular and Diabetes (**Dawson**) and Cancer. Research foci include brain imaging in aging and dementia (**Waiter, Murray**), breast cancer imaging (**He**) and cardiomyopathy imaging (**Dawson**). The Fast Field-Cycling MRI, a next generation magnetic resonance imager instrument (**Lurie**) has been developed and is being evaluated in stroke diagnosis (**Lurie, Mcleod**). In 2019, the 3-Tesla MRI instrument originally installed in 2007 was upgraded, part of a GBP1,200,000 investment by the University and the Roland Sutton Academic Trust. NHS clinical use of the 3T instrument is shared, with research time devoted to School research. ABIC has been led for the majority of the review period by **Murray-A.**, and now **Waiter**; their research has focused in part on brain imaging studies, some involving the Aberdeen birth cohorts from 1936 and the 1950s, showing important differences in functional MRI during cognitive decline (PMID: 21859598) but including collaboration with other Centres such as *Cancer, Arthritis and Musculoskeletal* and *Cardiovascular and Diabetes*.

C: UoA1 Strategic Direction

Building on the strategy articulated in REF 2014, UoA1's clear strategic objectives are focused on our patient communities and their healthcare priorities. Using close working partnership between the research Centres and the NHS, economic development agencies and with the life science industry cluster via the forthcoming GBP40,000,000 (ACRD)-funded *BioHub* incubator, we will deliver excellence in both challenge-led and fundamental research. We will take advantage of our embedded interdisciplinarity as a lever to realise healthcare and biotechnological impacts. We have a series of strategic objectives, articulated in the following sections, placed in the context of the REF2014 vision.

Interdisciplinarity: In 2014, interdisciplinary systems biology was proposed as an area of strategic investment, and we have since invested in a number of inter-disciplinary appointments across the domain of UoA including: physicists (**Broche, He, Hiscock, Lurie, Romano** [UoA 12] and **Waiter**), engineers and chemists (**Blana** and **Greig** respectively) and health psychologists (**Allan, den Daas, Dixon, Powell**; underlined – appointed during the REF review period). Health psychology will play important roles for example in understanding dietary behaviours (Rowett Institute) and evolution of professional practice in healthcare staff. Our interdisciplinary ambition aligns with the recently formulated *Aberdeen 2040* strategy, which identifies challenge-led, interdisciplinary research as central to our University's ambitions. Its delivery is woven into the strategic vision for our UoA1 over the forthcoming REF period, with **MacFarlane** appointed as institutional Dean on Interdisciplinary Research and Impact. A retrospective analysis of the University's 5-year inter-School publications (*circa* 1000 papers) reveals strong published links between the UoA1/School and multiple other Schools (Figure 2), representing a rich seam of interdisciplinary research already in place.

Interdisciplinary research is frequently a driver of innovation to address stakeholder challenges, for example, **Blana**, who is applying engineering modelling principles to the challenge of prosthetic limb control and managing patient flow in hospitals. Equally, discovery science benefits from novel angles of disciplinary "attack", for example, **Hiscock's** work on the use of mathematical modelling of

developmental biology process and **Brown-A's** work on modelling of fungal stress responses. Our aim is therefore to assemble interdisciplinary teams through targeted expertise, matching and networking across the University. In achieving both challenge- and curiosity-led outcomes, we will be aided by our Research and Innovation unit's *Conversations On* series and interdisciplinary sandpit events, which forge researcher collaborations across discipline boundaries. Our Head of School **Bhattacharya-Si**, is proactive in leading engagement with other disciplines, for instance, in hosting research exploration meetings with other Schools, which have led to new collaborations in areas including law and computing sciences. We will use the excellence of the established Centres as a fulcrum to deliver challenge-led impacts in the medical sciences.

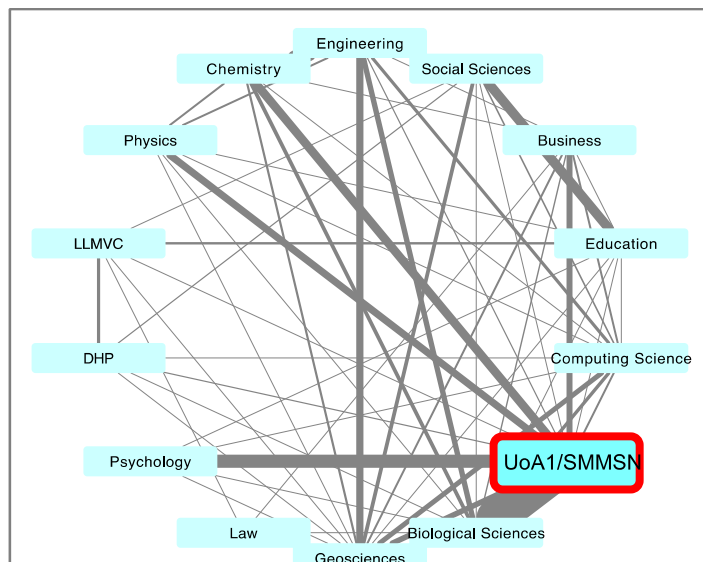


Figure 2: Interdisciplinary interactions (defined by publication) between Unit of Assessment 1 (SMMSN) and the University's other Schools; link widths as proportion of *circa* 1000 publications

Development of our Centres: The 2014 strategic aim of building strength in our cognate research groupings, including fostering ECR talent, is exemplified by the model of our Centre for

Medical Mycology, which capitalised on large programme grants, culminating in its MRC Centre award, with the development of a number of ECRs to academic independence (Rudkin, D. Wilson, Childers, Ballou). It is a testament to the environmental support provided by UoA1 for building research capacity.

Strategic investment and growth of research in energy metabolism and obesity was planned in 2014, and in the last review period the Rowett Institute was integrated into the Foresterhill Healthcare Campus with the building of a GBP40,000,000 human nutrition building (one of only two in the UK), and the Aberdeen Cardiovascular and Diabetes Centre was instituted. This combines IMS, IAHS researchers and clinicians with Rowett nutrition research expertise (**Ramsay, Heisler, Gonzalez Sanchez**, including new strategic investment posts **Naneix, Sylantyev**). These investments in the neurological control of dietary intake also cement existing close interactions between the Cardiovascular and Diabetes Centre and the Rowett Institute.

Further development of neuroscience was a 2014 strategic objective and investment posts linking neurodevelopment with stem cell biology and psychiatric disease (**Berg, Kang**) developments in the FFC MRI (**Lurie, Broche**), and the research team associated with the TauRx spin-out, have each further strengthened Translational Neuroscience.

We will use the new appointments made to further develop areas of investment such as cancer (part supported by the *Friends of Anchor* charity; GBP5,000,000; **Speirs, Anderson**), health psychology (**Dixon, den Daas**), translational neuroscience (**Kang, Berg**), and satiety and obesity regulation (**Naneix, Sylantyev**). Additionally, we will continue to seek advantage within the Centres from an integration of methodological expertise across the Institutes, using our applied health science expertise to evaluate healthcare innovation emerging from translational medicine.

Delivering impact: We will pursue a number of parallel impact strategies, taking advantage of close partnership working with the NHS, a rich source of challenges requiring research solutions, supporting the pipeline of commercialisation ideas with the forthcoming *BioHub* incubator.

Through close liaison working with our NHS partners, using the already-established NHS-University-Industry liaison group *Triple Helix*, we will promote tripartite partnerships focused on innovation-based solutions for specific NHS stakeholder challenges. These research projects are being presented to an interdisciplinary University community through *Challenge-led Conversations* On sandpit events.

Nutritional research impacts: Following the GBP40,000,000 purpose new-build, planned in the REF 2014 strategic vision, the Rowett Institute is now fully integrated onto the Foresterhill Health Campus. This will be central to our strategy of integrating interdisciplinary nutrition science into challenge-led research, as articulated in the institution *Aberdeen 2040* strategy. Our Scottish government-funded nutritional science RESAS programme in the Rowett Institute will be used to drive impacts in the food industry, public health policy and practice.

Life sciences and drug development impacts: Supported by **Delibegovic**, as the Institutional Dean for Industrial Engagement in Research and Knowledge Transfer, we will build on our strengths in the biologic and drug development spin-outs (five during the assessment period) to achieve further impact in biotechnology and pharmaceuticals research. We will use mechanisms such as the University's *Challenge-led Conversations* On sandpits, the School's Kosterlitz Centre for Industrial Engagement, and Lead for Industrial liaison **Wallace-H** working with *Research and Innovation (R&I)* to establish industry-UoA1 networks. Those elements of impact strategy position us to catalyse spin-out activity and take advantage of the ACRD-funded *BioHub* incubator for life science companies, to be based on our Foresterhill Health Campus (UoA1 colleagues **Porter** [Elasmogen CTO] and **Cruickshank** [NHS Director of R&D] are *BioHub* Board members; see *Section 3*).

Interdisciplinarity as a fulcrum for challenge response: Our interdisciplinary research capacity will act as the foundation of our response to challenge-led research opportunities including those originating from our NHS partners and UN Sustainable Development Goals SDG2 (Zero Hunger) and SDG3 (Good health and wellbeing). The breadth of our expertise base puts us in a strong position to capitalise on these clinical and other interactions. We will also continue to foster NHS

research linkages through strategic School research support for clinical colleagues undertaking NHS Research Scotland Fellowships (e.g., existing NRS Fellows NHS colleagues Masannat, Elsberger, Kaye).

Capacity building: People are at the heart of our capacity building strategy, creating an environment that allows researchers to flourish at every career stage of their careers. At the PhD level, we will seek new doctoral training partnerships and collaborative training partnerships with industry, conscious this is likely to be through multi-Institution (DTP) or industry (CTP) collaboration. Central to this will be a vibrant training environment for PhD students within the School, led by **Speirs** (School PGR lead) and **Nixon** (UoA1) providing Institutional leadership as the Dean of the Post Graduate School.

Our capacity building strategy also depends on a vibrant and supportive environment for our Post-doctoral Research Associates (PDRAs), further developed by our alignment with the *Vitae Researcher Concordat*, and the recommendations for positive change that will emerge from the University's Research Culture working group (chair; **Macfarlane**), and externally, the Wellcome Trust review of research culture. The evolution of our ECR progression strategies will be aided by recommendations from the University's Postdoctoral Research Committee (Chair:

Delibegovic, UoA1), the Researcher Development Unit and our School's *NVision* PDRA network.

We will capitalise on our School's/UoA1 new appointments, which have strengthened both our Centres and our interdisciplinary potential. A number of these appointments are at Lecturer level, and our probationary and mentorship structures, together with early years professional development support, articulated in Section 2, will be vital to support their development. Our human resource processes and practice must also be continually and self-critically examined, and our Unit's equality and diversity record across all protected characteristics will be under constant review, for example, as we seek further School-wide Athena Swan accreditation and play our part in addressing the society-wide challenge of achieving racial equality.

Open Research: We recognise the need to support our research ambitions with a full commitment to the principles and practice of *Open Research*. Our commitment to FAIR principles (Findability, Accessibility, Interoperability, and Reusability) underpins our research findings release strategies (Section 3E). We have membership of a UK-wide Research Reproducibility Network, are strong advocates of ORCID registration for our researchers, and the University is a signatory of the San Francisco Declaration of Research Assessment (DORA) underscoring our commitment to fair assessment throughout a person's career.

Technology integration: In REF 2014, further development of the School's Core Facilities was planned, with a (now delivered) major investment in the Centre for Genome Enabled Biology and Medicine, the creation of an associated 3-person post-doctoral Bioinformatics Unit and investment in the Iain Fraser Cytometry Centre. We will use our Technology Hubs, the Centre for Health Data Science and its associated Data Safe Haven and the Core Facilities to catalyse cross-School research discovery. These assets will also be used to catalyse and support close interactions with companies in the new *BioHub* incubator, together growing the number of digital/health data science companies across the region.

2. People

Introduction

Our research strategy is underpinned by a strong commitment to the development of staff and students at every career stage, doctoral training, through Early Career Researcher (ECR) and to their continuing professional development as established academic staff. Our development programmes place equality and diversity at their heart.

Postgraduate student training

Doctoral training is managed centrally by a University-wide Postgraduate School (led by **Nixon**) that delivers harmonised training across the University. Our School's PGR Lead (**Speirs**), and Institute-level PGR Leads direct doctoral training and recruitment. Over the review period, 337

students have completed their PhD training and successfully graduated (average 48/year). Using standard UKRI reporting methodology, we achieved 4-year PhD programme completion rates of 85% and 98% for students starting in 2014 and 2015, respectively.

PhD training over the review period has included 14 students funded by the Wellcome Trust Strategic Award and Centre for Medical Mycology (MRC funded). Among this cohort were six clinical PhD studentships, to foster the development of researcher clinicians. UoA1 PhD training is also underpinned by the 29 students funded over the review period by the BBSRC *EastBio* Doctoral Training programme, held jointly with the Universities of Dundee, Edinburgh and St Andrews. It delivers a strong 4-year programme of inter-University training events involving distributed networks of students and supervisors. The EastBio DTP, now with partnership industry funding and the 3rd largest BBSRC DTP in the UK, has received unbroken 3rd generation funding after successful renewals in 2015 and 2019, a testament to quality of training delivered.

The University has improved the reach of its PGR programme with its *Elphinstone Scholarship*, a full international tuition fee waiver scheme that allows the best students from across the world access to our doctoral training (77 Elphinstone Scholars since 2014).

At recruitment, prospective PhD students are interviewed by an independent panel. During their training, students select from a range of generic and research training courses. The students are assessed at nine months by a first-year report and viva, guiding a “*progression to year 2*” decision. It allows students to feedback to the panel on the quality of their supervision. They are assessed at 24 months by a research manuscript-style report. Twice a year a student organising committee delivers a highly successful, UoA1-wide, PGR Conference. There were 347 papers published over the review period where at least one of our PhD students was author (an average of 1/student), a testament to the quality of doctoral training provided in UoA1.

Early career researcher (ECR) development pathways

A supportive career development pathway for post-doctoral scientists is an important environment component. The University is a signatory of the *Vitae Concordat to Support the Career Development of Researchers* and has successfully gained the HR Excellence in Research Award in 2014, 2016 and 2018/19, demonstrating alignment with the European Charter for Researchers. Our delivery of the *Vitae Concordat* principles is led by the University’s Postdoctoral Committee, chaired by **Delibegovic**, UoA1, with representation from research staff (including UoA1), HR and the Researcher Development Unit. PDRAs can attend institutional Fellowship training workshops but can also proactively lead their own professional development events through a University small grant scheme, the *Research Futures* fund.

Development of PDRA careers within UoA1 is also supported through local mentorship, delivered via the School’s *NVision* Researcher Development Network for PDRAs. *NVision* is directed by a former British Heart Foundation Fellow, **Mutch** (UoA1; now Reader), and the committee is convened by an experienced PDRA, Ashraf. PDRAs are encouraged to submit Knowledge Transfer Partnership (KTP) applications and to engage with CPD leading to an Advance HE teaching qualification.

For those PDRAs aiming at independent research careers, the School mentors development of applications to independent fellowship schemes via the University’s *Grants Academy* (see section 3A) Traffic Light scheme. Candidates’ CV and project proposals are reviewed by senior academics through in-person discussion. Following a “green light” they are assigned an application mentor, peer reviewer(s), a fellowship “buddy” and a personal application timetable. Those not receiving a green light are given detailed feedback to support resubmission. Peer review of the application is supported by practice interview sessions for those who are selected for funding body interview. This support process has been highly successful, for example, helping PDRAs secure Wellcome Trust ISSF 6-month Fellowship funding, and beyond that, a wide range of external independent fellowship funding, including Wellcome Trust Research Training and Clinical Research Training Fellowships, Sir Henry Dale Fellowship, MRC Career Development Fellowships, BBSRC Future Leaders Fellowship awards across all centres within the Unit.. Through the award to UoA1/the School of an MRC Discovery award, funding was

provided for an additional two Fellowships. Over a five-year period, 42 independent fellowship applications were submitted, of which 28 were from female applicants (62%), with an overall success rate of 19% (all funders, *cf.* typical BBSRC fellowship success rate of 8%).

Clinical staff: research initiation and development

We foster our translational medicine research portfolio by promoting the development of a clinical research pathway among our clinicians. This is achieved through the activities of the *Aberdeen Clinical Academic Training and Development Pathway* (ACAT: Fig. 3) directed by **Myint** (UoA1). ACAT oversees five stages of the development of clinical academics:

[1] grass-roots, year 1 and 2 medical student research experiences through research scholarships (average 20/year).

[2] a summer Hot-start research internship at undergraduate years 3 or 4 (average 8/year), or alternatively, an intercalated undergraduate or Masters biomedical science degree, which includes a 10-week research project (average 44 MBChB students/year UG, 4/year PGT intercalation)

[3] Academic Foundation programme to help Foundation doctors develop research skills during F1/F2

[4] the two-year Early Career Academic Programme (ECAP), promoting later-stage fellowship applications or MD/PhD studentships (average 6/year)

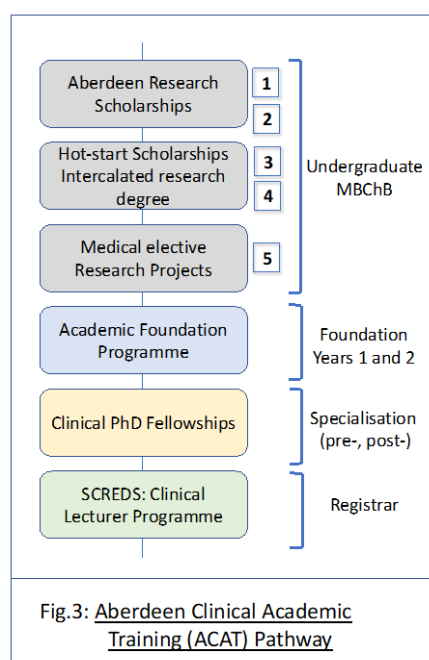
[5] at Registrar level, the Scottish Clinical Research Excellence Development Scheme (SCREDS) Clinical Lecturer positions; these provide integrated academic research (0.2 FTE) and clinical (0.8 FTE) training. Over the review period an average of 12 SCREDS positions were in post in any given year, integrated into UoA1 research groups. SCREDS lecturers with a PhD or MD have been returned as UoA1 independent researchers. The School also provides 50 places per annum on the on-line BMJ *Research to Publication* course for early career clinicians.

At consultant-level, the School actively mentors clinician applications for competitively-awarded NHR Research Scotland (NRS) Fellowships. In the last five years, a total of six NRS Fellowships have been awarded to NHS-Grampian clinicians working with UoA1 research groupings, for example, the Aberdeen Cancer Centre (clinicians Elsberger, Massanat) and the Centre for Women's Health (Saraswat). The University recognises senior clinician research trajectories through the award of Honorary Clinical Chairs; (nine currently in NHS-Grampian).

Established researcher training, mentoring and development

Throughout their academic careers, staff require continuing professional development. Newly appointed staff undertake a 3-year probation programme, with optional fourth year, and are set staged probationary objectives, supported by a mentor and line manager. Staff with a lab-based research programme are usually helped to establish their research with a PhD studentship, start-up funding and technical support.

Grant application support is delivered through the University-wide *Grants Academy* (delivered by *Research and Innovation* [R&I]). The *Supporting Grant Applications* (SGA) process begins with the applicant presenting an overview of the grant application to a panel of 3-4 colleagues with successful funding track records, with support from R&I on development impact plans. The resulting improved proposal is then submitted to peer reviewers for more detailed feedback. Sign off by the Head of Institute is required before submission. Where reviewer reports are provided by the funder, there is senior academic advice on rebuttals; an advisory debrief review takes place if funding is unsuccessful. The *Grants Academy*, with the School, has also funded 30



places on a grant writing mentoring course delivered by an external consultancy and developed internal *Bootcamps for UKRI*.

Staff research commercialisation and other impact development is supported by the School, for example, by facilitated buyouts of an academic's time by the spin-out company (e.g., **Porter**, UoA1, 50% buy-out by *Elasmogen* for a period of one year, ongoing) and by provision of incubator lab space and access to core facilities within the School, prior to life-science incubator tenancy (e.g., *mycoBiologics*, **Rudkin**, UoA1; *Sirakoss*, Gibson, UoA8). The School has also appointed **Wallace-H** as Industrial Engagement lead to coordinate the enhancement of research income from industry. Industrial engagement is frequently catalysed using Knowledge Transfer Partnership grants (North of Scotland KTP; currently four KTPs across UoA1) or PhD schemes such as *Medical Research Scotland* (five studentships over the review period) to cement links between a company and UoA1 research. Spin-out pathway "bootcamp" training events have been delivered to UoA1 staff seeking to commercialise research by Opportunity Northeast (ONE) in partnership with BioCity Newhouse, a national life-science incubator; since 2017, 38 researchers have attended *Introductory* events, and 16 researchers have attended the *Accelerator* advanced events.

Staff are supported and encouraged to assume external leadership and advisory roles. For example, **Ritchie**, (Chair of Health Informatics Research Strategy for Scotland and Scottish Government), **Porter** and **Cruickshank** (Opportunity North East (ACRD) boards), **Black-C.** (Covid-19 response epidemiology with NHS), **Cruickshank** (leadership of NHS-Grampian Covid-19 vaccination programme), **Gow** (President, Microbiology Society), **Porter** (Royal Society of Edinburgh) and **Macfarlane** (Steward of Scottish Parliament COVID-19 Citizens' Panel) have all received release from School duties to facilitate external leadership roles. During the Covid-19 lockdowns, 15 UoA1 clinical academics were released from University duties to contribute to NHS Covid-19 response teams.

Principal Investigators (PIs) undertake mandatory PhD supervision training courses, with top-up PhD training at regular career intervals. The School also runs annual residential PI professional development courses for early/mid-career staff, with senior academics acting as tutors and led by the University's Centre for Academic Development and the Researcher Development Unit. Since 2014, five of these courses have been run with an average attendance of 20 staff. These courses have multiple early career training objectives, raising research standards and aspiration and fostering a sense of community across discipline boundaries and a large healthcare campus.

At regular intervals throughout the review period, in partnership with an external training consultancy, the University has run its award-winning International Leadership Development Programme, involving managerial HEI training and fact-finding visits to a University overseas, which eight senior academic and professional services staff from UoA1 have so far attended. The professional development of female academics, and those identifying as female, is supported by the School's annual funding of *Aurora Higher Education Leadership Development Course* attendance for a member of staff. A mentorship partnering service is available for any member of staff.

Staff recruitment is driven by the requirement to invest further in areas of research excellence and by the University's *Aberdeen 2040* strategy and its *Interdisciplinarity* theme. It also aims to appoint staff with research interests that cross discipline boundaries, for example, **Blana** (engineering), **Broche** and **Hiscock** (physics). All lecturer and senior lecturer staff have been appointed on full-time *Teaching and Scholarship* contracts. Succession planning to manage staff demographic shifts over time is achieved through the network of Centre leads, Institute Directors and their Deputies.

Staff equality and diversity policies

All new University policies are subject to a full audit by the University's Equality, Diversity and Inclusion (EDI) Advisor and EDI group. At School level, all five of the component Institutes have secured Bronze Athena Swan awards and are now seeking advancement to Silver at School level. The School has an established (2015) financial support scheme "*Family Award for*

Scientific Conferences” to provide childcare and caring responsibility support for staff wishing to attend conferences.

The EDI framework aligns closely with the *Inclusion* pillar of the University’s *Aberdeen 2040* strategy, with clear Key Performance Indicators. As part of this strategic priority, the University is a signatory of the Advance HE’s Race Equality Charter, aiming to improve the representation, progression and success of minority ethnic staff and students. Our School has also signed the British Medical Association Charter on Racial Harassment. Delivery of charter commitments is driven by a joint NHS and University Race Equality Task Force and by the University EDI Committee, including student members. A Race Equality Strategy Group steers the development of a University Race Equality Strategy, including an action plan to respond to the recommendations of Equality and Human Rights Commission report “*Tackling Racial Harassment: Universities Challenged*”. The School’s four Race Equality Champions enable race equality issues to be surfaced by any colleague. Our 19% BMEO PDRA proportion within UoA1 is higher than the HEI sector average (15%), although the need for significant further progress is acknowledged.

All roles within the School are advertised to all staff, and appointments are made after panel interviews to meet equality and diversity guidelines. As a result, with respect to gender in our senior research roles, 11/21 research programme leads are female, as are 6/13 Centre leads, and 5/9 of the Directors and Deputies of the three research-intensive Institutes. Within the UoA1 postdoctoral researcher community, the proportion of female (f) staff (65%) is significantly higher than broader University and HEI sector data (46% and 54%, respectively). All staff involved in external recruitment processes must have undertaken equality training. Staff promotion processes are subject to Equality Impact Assessments (EIAs).

The University has formalised 1-year sabbatical and research mini-break schemes and staff are encouraged to apply for research leave support. For example, **Munro** (f; 2019) and **Hoppler** (m; 2020) both secured Leverhulme Research Leave Fellowships, supported by the School, which arranged reassignment of their teaching and administrative duties. Sabbatical applications are welcomed from full-time and part-time staff at all career stages including ECRs but particularly from those returning from maternity or long-term sick leave. Priority will also be given to those whose research was interrupted or impacted by Covid-19. Schools are asked to carry out EIAs of staff awarded such leave.

Staff returning from parental leave, or leave for other caring responsibilities, or after long-term ill health are asked to attend a return meeting with their line manager. Our Wellcome Trust *Institutional Strategic Support Fund (ISSF, see Section 3A)* included a Returners Scheme that supports individuals following parental leave or ill health. Long-term ill health effects are managed with the help of occupational or reasonable adjustments, for example phased return, altered start and/or finish times or a period of homeworking. Parental leave returnees are supported with the *Parents Network*, a dedicated *Parents Handbook*; a network of School *Parents Champions* offers experienced support to new parents. The University is also committed to making a range of adjustments for staff with disabilities including, for example, flexible working and workplace adjustments.

Wellbeing, illness, flexible leave policies

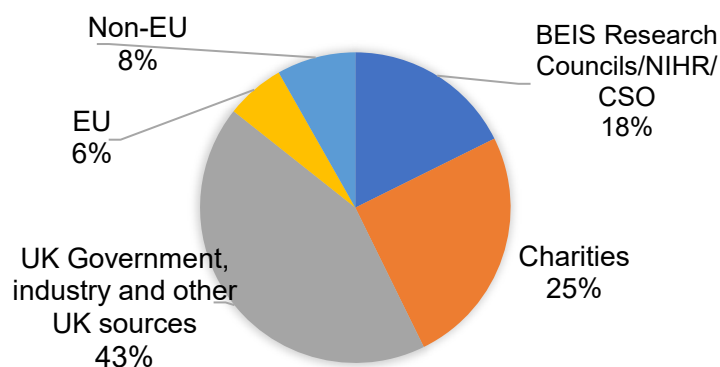
The University has a range of policies and practices in place to support the wellbeing of staff. It is committed to constructively examine proposals from staff seeking part-time or part-year working, job sharing or flexible working hours. It has an annual leave purchase scheme, allowing up to two week’s additional leave to be secured. The University has an open, established mentor scheme. There are Wellbeing Coordinators and Mental Health champions based in each School. The University runs a Workplace Dignity Network to provide support to staff in cases of bullying/harassment, stress, work relationships, work/life balance or mental health issues. The University also runs mental health first-aid courses for staff, mental health awareness training courses and provides access to *The Big White Wall* mental health support service. The University actively supports *Inclusion Week* with campus-wide events highlighting inclusion issues.

3. Income, infrastructure and facilities

3A: Income

Our success in delivering an average of GBP25,600,000 in income per year from a diversity of sources (Fig. 4) results from a breadth of research focus on pure biomedical science, translational medicine and industrial impact-centred research, including a 5-year GBP37,500,000 RESAS grant from Scottish Government to deliver the Rowett nutritional science programme. The Institute of Applied Health Science (IAHS) and Rowett Institute are ideally positioned to make transformative impacts in health care and food policy/strategy, respectively.

Figure 4: Funding Sources



Fundamental research across all five institutes is able to target UKRI and medical charity funding. These funding foci are supported by our University's *Research and Innovation* section, which delivers our *Grants Academy* framework, supporting both early grant ideas testing and later-stage peer review.

A partnership of *R&I* and School provides strong support for grant applications; four dedicated *R&I* staff support the staff member's bid development, grant application and costing processes. Two additional *R&I* Business Officers work with UoA1 staff on strategic targeting of funding opportunities. They also help preparation for staff targeting personal fellowships including interview practice with mock panels of senior staff. This support has been instrumental in prestigious junior fellowship successes (eg., **D'Agostino, Brand, Adam**; Table 1) and senior Wellcome investigator awards (**Gow, Brown-G.**). *R&I* support within UoA1 has also been pivotal for major grant success, for example, a Wellcome Trust Strategic Award for Medical Mycology and Fungal Immunology (GBP5,100,000). UoA1 also secured a Wellcome Trust Institutional Strategic Support Fund (ISSF) (GBP2,100,000 with GBP2,200,000 of matched institutional support), an MRC Centre for Medical Mycology award (GBP2,800,000 with GBP2,300,000 institutional support) and a GBP37,500,000 grant from Scottish Government to deliver the Rowett nutritional science programme.

In partnership with *R&I*, the School delivers the *Supporting Grant Applications* (SGA) framework, a mentorship process in which an applicant receives early-stage feedback on their application from a panel of experienced academic staff. Late-stage proposals are then subject to peer review by senior colleagues with established funding records. To rapidly respond to the short-deadline Covid-19 research funding schemes of 2020, the SGA support processes were streamlined, facilitating successful applications to the Scottish Government Chief Scientist Office *Rapid Research in Covid-19* RARC programme (GBP970,000 across six projects).

The *Grants Academy* coordinates assignment of reviewers with particular expertise, for example, with national grant review panel experience. The *Grants Academy* also manages internal funding opportunities to pump-prime research and knowledge exchange grants - including the Global Challenges Research Fund Internal Pump Priming Fund (GCRF-IPPF); the Wellcome Trust ISSF; the Core Facilities Voucher Scheme; the Research Enhancement Scheme; and the Impact and Knowledge Exchange Fund, each designed to catalyse research funding and impact success. Priming support for GCRF is aimed at UoA1's focus on United Nations Sustainable Development Goals SDG2 (Zero Hunger) and SDG3 (Good Health and Wellbeing), with successful awards to **Russell** (BBSRC GCRF; GBP450,000; moringa as a sustainable food source in Malawi; SDG2) and to **Haggarty** (an MRC GCRF Hub

GBP18,200,000/GBP900,000 UoA1 share; childhood nutrition in LMI countries, *Action Against Stunting Hub*; SDG3).

The *Grants Academy* also supports industrial collaboration and applications for knowledge transfer funding, coordinating applications for Knowledge Transfer Partnerships (KTPs) and Innovate UK applications. It provides support for spin-out company launch, venture capital funding, patenting and licensing. The University has invested into the Venture Capital Epidarex Fund (III) providing a further source of investment for UoA1 and life science companies (see REF5a), for example, UoA1 spin-out Sirakoss receiving investment from Epidarex.

3B: Investment

Strategic investments during the review period (section 1C) have enhanced existing areas of strength and further developed our interdisciplinarity within our cross-cutting Centres, appointing three physicists and engineers during the review period. These core positions were complemented by PDRAs appointments; an MRC Discovery award scheme (**GBP450,000**) was used to support obesity and satiety neuroscience, (two Fellowships) and pump-priming PDRAs to develop capacity in the Rowett Institute in energy metabolism and neuroscience. The Wellcome Trust ISSF (**GBP2,100,000** with **GBP2,200,000** of matched institutional support) was used for strategic investment (including PDRAs) within the strategic areas of (i) Infection, Inflammation and Immunity (ii) the molecular basis of obesity (iii) applied health science and (iv) regenerative medicine, particularly within arthritis and joint disease, leveraging **GBP7,500,000** of new funding in those areas.

3C: Infrastructure and equipment, research facilities

Physical Infrastructure;

- (i) As part of the School's and University's strategic plan at the last REF, the University invested **GBP28,000,000** of the GBP40,000,000 total cost of a state-of-the-art nutritional sciences building to centrally locate the Rowett on the Foresterhill Health Campus. The new building houses 160 researchers and incorporates a 7-bedroom residential Human Nutrition Unit (HNU) for dietary intervention studies, an exercise facility, a body composition measurement suite and a DEXA scanner.
- (ii) Now with finalised plans and secured funds, building of a **GBP40,000,000**, 6400 m², 300-person life-science incubator (*Biohub*) is underway, to be located adjacent to the School on the University's Foresterhill Health Campus.
- (iii) Having secured funding of **GBP270,000** from the Jules Thorne Trust for the next generation Fast Field-Cycling MRI, instrument construction is underway. The University has now committed **GBP1,600,000** to complete instrument design, assembly and installation in a new clinical FFC facility in a building contiguous with the hospital to allow patient clinical trials.
- (iv) Research space for clinical and other academics, including the new University appointment clinical oncology Chair, will be available in the **GBP233,000,000** Baird Family Hospital and Anchor Cancer Centre, both being built on the Foresterhill Health Campus for opening in 2023.

Technology Hubs: Biomedical bench science is underpinned by a range of world-class analytical *core* facilities in our Technology Hubs, overseen by a University Infrastructure Committee, chaired by **Nixon**. Each hub has service delivery led by a highly experienced core facility manager and an assigned academic lead to interface with academic users. Equipment upgrade and renewal is delivered through a combination of external grant funding and institutional support. The Technology Hubs deliver access to both academic and external industrial users. Hubs such as cytometry, genomics, proteomics and imaging, underpinned by excellence in animal facilities, are a key element of our strategy to deliver biomedical laboratory research excellence across our Centres and the Rowett Institute.

The Hubs include **Cytometry**, which supports research in immunology, microbiology and cancer, central to our strategic ambitions. It has available a range of four cytometers and a BD Influx cytometric cell sorter, a BioPlex 200 for multiplex bead analysis and an Image Stream for single cell image cytometry (one of only two in Scotland).

Genomics research is served by **The Centre for Genome Enabled Biology and Medicine** with next-generation sequencers (Illumina Miseq, Illumina NextSeq500, Ion Torrent Proton sequencers, Oxford Nanopore for long read sequencing) and a dedicated single-cell lab with 10x Genomics Chromium system for single-cell RNAseq.

The **Microscopy and Histology** technology hub delivers confocal laser scanning microscopy; LSM 880 with Airyscan (Wellcome Trust Multi-User Equipment Grant led by **Erskine** [GBP330,000 with GBP85,000 institutional investment]), LSM170 confocal and a spinning disk, UltraVIEW 3D live cell imaging system, fluorescent microscopes, transmission and scanning electron microscopy plus Skyscan/Nikon Computed Tomography systems.

The **Proteomics** and **Mass Spectrometry Analytical units** have available a quadrupole-Orbitrap Thermo Scientific Q Exactive tandem mass spectrometry system (GBP415,000 Wellcome Trust grant led by **Brown-A.**, with GBP100,000 institutional investment), mass spectrometer for gas stable isotope ratio measurements, MALDI Imaging Mass Spectrometry, Biacore surface plasmon resonance and an automated sample digestion unit (GBP50,000 and GBP84,000 institutional investment, respectively).

Other key facilities supporting research across our integrative Centres include the **Scottish Biologics Facility**, providing *Antibody and peptide library screening services* and the **Medical Research Facility**, a rodent, zebrafish and *Xenopus* model organism facility located on the Foresterhill Health Campus. Human nutrition intervention research is carried out in the **Human Nutrition Unit**; a 7-bed en-suite research facility.

Finally, supporting our complex research structures, (i) the University *Information Technology Services* provide IT support across UoA1, covering data management, information governance, research instrumentation and a **High Performance Computing** cluster, Maxwell, giving researchers access to 1240 CPU cores and 12TB of RAM and (ii) working closely with *R&I*, the School provides administrative support for research and PGRs, a vital facilitator of our research activity.

Collections and Archives; The School has access to a number of world-class archives, tissue collections and birth cohorts. The *Aberdeen Children of the 1950s (ACONF*; births from 1950-1956) birth cohort has allowed us to follow 12,150 people as they grow and age, for example, using MRI imaging of cognitive resilience and decline. CHDS is custodian of the Aberdeen Maternity Neonatal Databank.

The University of Aberdeen and NHS Grampian runs an ISO27001:2013-accredited Grampian Data Safe Haven (DaSH; academic leads **Black-C.** and **Anderson**). Safe Havens provide a governance framework for the protected use of pseudonymised NHS patient data in research. Aberdeen's Safe Haven is one of only four in Scotland and since 2015, is a *Charter for Safe Havens in Scotland* signatory. The School hosts a number of important tissue banks including the Chief Scientist Office-NHS funded *Grampian Biorepository*, a tissue bank with built-in ethics approval (accredited by Health Improvement Scotland).

3D: Research governance

The University's overarching research governance structure ensures that our research meets the highest ethical standards. We comply with the five commitments set out in the *Universities UK Concordat to Support Research Integrity*, seeking the highest standards of excellence, honesty, integrity, rigour, transparency, accountability, showing care and respect for research participants and fostering both disciplinary and interdisciplinary approaches. Our delivery of good research governance and integrity complies with the UK Research Integrity Office (UKRIO)

standards and codes. Research integrity training is compulsory for all researchers, including PGR students.

The University's Research Policy Committee (RPC), chaired by the Vice Principal for Research, has overarching responsibility for research ethics and governance arrangements; it reports to University Court, Senate and to the University's SMT. The RPC receives reports from University Ethics Review Boards (ERB). Two of these operate within UoA1, the Life Sciences and Medicine Research ERB and the Rowett Institute ERB (for nutritional intervention studies), both reviewing studies not requiring approval from the NHS' North of Scotland Research Ethics Service.

The School employs a Research Governance Manager and Officers to help researchers to obtain sponsorship for their clinical studies. The Governance team advise researchers on study design and submission of applications to regulatory bodies. They oversee the ongoing management of the clinical studies from study initiation to archiving. All clinical studies are subject to monitoring and audit by the NHS Quality Assurance team in collaboration with Research Governance. Research Governance also work closely with *Research and Innovation* to discuss contractual requirements and comment on funding applications. Much of the School's research is partnered with colleagues in the NHS, these collaborations are facilitated by a Joint Working Protocol and co-sponsorship agreements. The healthcare campus is thus a single governance environment with robust joint working arrangements in place.

Research involving animals is governed institutionally by the Advisory Group to the Establishment Licence Holder and the Animal Welfare and Ethical Review Body, which carries out robust ethical reviews on all research proposals submitted to the Home Office as part of a project licence application. The School's Biological Safety Committee oversees and licences genetically modified organisms research.

The University has mechanisms to deal with any alleged shortfall in research governance practice and research misconduct. In this event, Stage 1 preliminary investigations by the School Director of Research may lead to a Stage 2 process, involving a Dean for Research convening a four-person committee that includes the Vice-Principal for Research. The research governance framework identifies the Head of School as arbiter over disputes concerning authorship.

3E: Open Research, reproducibility and integrity

The University, and School/UoA1, recognise the importance of open research, incorporating the FAIR principles (Findability, Accessibility, Interoperability and Reusability), which are being applied to *Open Access, Data and Platforms/Tools*. The University Library, *Special Collections and Museums* Directorate leads advocacy of Open Research. The Library runs the Aberdeen University Research Archive (*AURA*), our open access repository that receives all publications, where permitted by the publisher - 1,141 UoA1 research publications have been lodged since 2014. UoA1 researchers take advantage of early manuscript release on the pre-print repository BioRxiv (26 released in 2019/20). Supporting FAIR data accessibility and reusability, 39 datasets have also been uploaded into the AURA repository since 2014 and another 40 genetic and proteomic datasets released via open access databases such as the Gene Expression Omnibus and PRIDE (proteomics).

At the School level, we are embedding the principles of open research and integrity at the level of PGR training, using research reproducibility as one of the themes of a recent PGR Symposium run by our PGR committee and at the PDRA level, through the activities of our PDRA-led Research Reproducibility Group, (chaired by Butler; the School/UoA2) that leads Aberdeen's membership of a UK-wide Research Reproducibility Network. Finally, the University Library strongly advocates ORCID registration for unique researcher identification (Open Researcher and Contributor ID); 79% of UoA1 staff have ORCID identifiers.

3F: Investment leading to impact:

The School/UoA1 catalyses industrial collaboration using the new Kosterlitz Centre for Industrial Engagement and has appointed three professorial staff to drive industrial engagement; (i) **Delibegovic**, working across the University as Dean for Industrial Engagement in Research and Knowledge Exchange and (ii) **Wallace-H** and **Porter** to drive industrial engagement across the School by actively identifying new industrial partners working in partnership with R&I's Knowledge Exchange and Impact team. There is a University-level competitive pump-priming fund (Research and Innovation *Grants Academy*) for early-stage commercial activities with the goal of catalysing industrial engagement and initiating company spin-out. The University is also an investor in the Epidarex venture capital Fund II and Fund III, specifically aimed at bridging the funding gap for early-stage companies in Scotland. The University is a partner of the private economic development agency Opportunity North-East (ONE), a delivery partner for ACRD. The life-science and biotechnology sector is one of four foci of the ACRD, and the delivery of a GBP40,000,000, 6400 m², 300-person life-science incubator, *BioHub*, is underway. This incubator will be located adjacent to the School on the joint University-NHS Foresterhill Health Campus. The Technology Hubs of the School will be available for the companies in the *BioHub* and regional industry partners. The School/UoA1 staff (**Porter**; CTO, Elasmogen Ltd) and School/NHS (**Cruickshank**; NHS R&D Director) are centrally involved in planning the delivery of the *BioHub*. Our DaSH team and the Safe Haven provides expertise and collaborative opportunities through the Aberdeen-based ONE Tech Hub, promoting the growth of the digital technology sector within the region.

The University's R&I unit has the role of fostering research leading to impact, and there are two dedicated R&I business officers assigned to the School, an Impact Officer and a Commercialisation Manager. The latter person leads academics and their research discoveries through intellectual property protection, commercialisation, licensing, spin-out and eventually securing venture capital support to enable transition to full commercial spin-out.

Engagement with diverse audiences

Our UoA1 staff's responsibility to communicate their research to diverse audiences is supported by the University's *Public Engagement Researcher Unit (PERU)*, which organises a series of *Café Med* (monthly from Jan to May, Foresterhill campus) and *Café Scientifique* (monthly, Feb-Nov) events, normally allowing informal face-to-face contact with the public for evening presentations, and latterly, due to Covid restrictions, *Café Connect* podcasts. Public and stakeholder engagement is supported by the University's Communications section, which publishes an average of 70 articles per year featuring School research discoveries and impacts. A significant number of UoA1 staff contribute to the University's annual *May Festival*, which includes a diverse range of lay science events. Historically, it has brought 4000 people onto campus.

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

4A: Collaboration

Overview and evidence of collaborative success:

UoA1 staff participate in two Scottish Funding Council *research pooling* initiatives. These collaboration-stimulating networks drive strategic HEI investment and critical mass acquisition. UoA1 staff have played lead roles in two such pools; Scottish Life Science Alliance (SULSA; 11 Scottish Universities; **Mccaffery** [*Steering Committee*], **Delibegovic**, **Greig**, **Erskine**, **McEwan** [*Theme lead*]) and the Scottish Imaging Network (SINAPSE; seven Scottish universities; **Murray-A.** [Director], **Waiter** [*both Steering Committee*]). SINAPSE partners, including Aberdeen UoA1 staff, led the establishment of the Industrial Centre for Artificial Intelligence Research in Digital Diagnostics (iCAIRD), a GBP10,000,000 15-partner collaboration involving industry (Philips and Canon Medical). School investment in these pools allows access to their PDRA career development and industry-collaborative funding schemes. Staff in UoA1 secured seven SULSA and SINAPSE awards to support ECR research-exchanges.

Our School is integrated into the collaborative BBSRC PhD Doctoral Training Partnership *EastBio* led by Connolly (UoA5) and **Miller**. With now third-generation funding, it creates a

collaborative DTP with Dundee, Edinburgh, St. Andrews, Stirling and the Industrial Biotechnology Innovation Centre (IBiolC; industry-led CTP training). Each of the PhD projects funded by *EastBio* is advantaged at the shortlisting stage by partner-University co-supervision arrangements, promoting supervisory team collaboration throughout the 4-year PhD.

During the review period **Brown-A, Fowler, Gibson, Lurie, Miller, Munro, N'Dow, Riedel, Walker, Wilson**, and **Zanda (UoA5)** secured EU collaborative awards totalling GBP9,260,000, (underlining; *Innovative Training Awards* (ITN) PhD training). This EU funding included GBP1,030,000 for the development of FFC MRI (**Lurie**) as part of the IdentIFY network. The University's R&I unit and its European Business Officers support UoA1 staff making EU funding applications. **Cruickshank** has acted as WHO consultant on HPV immunisation programmes in Eastern Europe. GCRF funding has built new international collaborations; **Haggarty** and **Walker** are investigating the effects of malnutrition on child growth stunting and its life-long health consequences (GBP970,000; India, Indonesia, Senegal); **Russell** is investigating the moringa tree as a food staple in nutrient-deprived areas of Africa (GBP460,000; Malawi). **McEwan** holds a multidisciplinary MRC-DPFS award (GBP1,100,000) including Rotterdam Erasmus Medical Centre.

We are strongly connected with UK and EU research networks; **de Roos** is the CEO of the European Nutrigenomics Organisation (NuGO), a network of 28 Universities. **Macfarlane** is Deputy Director of the *MRC-Versus Arthritis National Centre of Excellence for Musculoskeletal Health and Work* (hub; Univ. of Southampton), a 17-University collaboration funded to 2024. Likewise, **de Bari** is Deputy Director of the GBP5,000,000 *Versus Arthritis Tissue Engineering & Regenerative Therapies Centre* at the University of Cambridge involving four other university partners. **Speirs** has established two international cancer research networks, the Male Breast Cancer Consortium and SEARCHbreast.

4B: Contribution to the research base

We make a wide range of significant contributions to the research base, the funding-research-publication pathway and to academic leadership in our respective fields as highlights show:

a. Research funding and publication processes

- i. **Journal Editors-in-Chief and Deputy Editors-in-Chief**; **Bhattacharya-Si**, Human Reproduction Open (Editor-in-Chief), **Barrett** Journal of Neuroendocrinology (Deputy) **Heisler**, Molecular Metabolism (Deputy) **Mercer**, Journal of Neuroendocrinology (Editor-in-Chief); **Munro**, FEMS Yeast Research (Deputy); **Wallace-H.**, Toxicology Research (Editor-in-Chief), Deputy Chair, Biochemical Journal (2009-2018). **Galley** is Director and Trustee of the British Journal of Anaesthesia (elected in 2018).

A further 18 oA1 staff are either Associate Editors, Executive Editors or Reviews Editors across 16 journals. A further 36 staff are members of Editorial Boards, with 45% of UoA1 staff having journal editorship roles.

- ii. **Grant review panels (Chair roles and major funders)**: **Adam**, CRUK Early Diagnosis Expert Scientific Review; **Bhattacharya-Si**, Panel Member UKRI Expanding Excellence in England (E3) Panel (2018-); **Counsell**, *Wellcome Trust*, Fellowships Implementation Committee, *Arthritis Research UK* (-2016); **de Bari**, *NIHR* i4i Challenge Awards Panel, *MRC* Regenerative Medicine Research Committee, UK (-2019), *EU Horizon 2020* Research Funding Programme, Clinical Research on Regenerative Medicine; **Delibegovic**, *British Heart Foundation* Project Grants Committee, *Diabetes UK Co-Chair*, Main Research Grants Committee, *Diabetes UK Chair*, Early Career Grants committee, member PhD studentship committee; **Galley**, *MRC* Clinical Research Training Fellowships; **Haggarty**, *BBSRC Chair*, Bioscience for Health Strategy Panel; **Hoppler**, *BBSRC* Response Mode Committee C and UKRI-BBSRC CTP2 Assessment Panel; **Lurie**, *Royal Society* Challenge Grants Panel; **Macfarlane**, *Versus Arthritis Vice Chair* of Health grant committee; **Maclennan**, *ESRC* Peer Review College, *Breast Cancer Now* grants committee; **McEwan**, Chief Scientist Office, Scottish Government,

Translational Clinical Studies Research Committee; **Murray-A.** MRC CASE studentships (2016-17). Overall, 16 UoA1 staff (12%) have membership of grant reviewing panels.

- iii. **Advisory bodies (major roles):** **Wallace-H.**, European Food Standards Agency, Vice-chair of CONTAM Panel, member of Panel on Food Contact Materials, Enzymes and Processing Aids, Contaminants in the Food Chain HMA; **Fowler**, Panel on Food Additives and Flavourings; **Ritchie**, Expert witness to Public Audit and Post Legislation Committee of the Scottish Parliament (PAPLs) – 2018; **Macfarlane**, member of the National Institute of Clinical Excellence (NICE) Low Back Pain Guideline Development Group (2014-16); **Galley**, Member of the National Research Ethics Advisory Panel (2015-2019).

b. Academic leadership and prizes

- i. **Academic prizes (significant examples):** **Heisler**, 2018 Outstanding Scientific Achievement Award, American Diabetes Association, 2018; **Erskine**, Suffrage Science (Women in Science) Award by MRC Clinical Sciences Centre; **Lurie**, Institute of Physics and Engineering in Medicine Academic Gold Medal (2017); **Macfarlane**, Alexander Morison medal by the Royal College of Physicians of Edinburgh, 2017; **Murray-G.**, Doniach Medal Lecture of the Pathological Society of Great Britain and Ireland, 2019. A further four researchers were awarded academic prizes from other bodies.
- ii. **Professional bodies and learned societies; elected memberships:** **Heisler** and **Ritchie** [2016]; **Hannaford** [2017]; **Murray-A.** [2018] - Elected Fellows of the Royal Society of Edinburgh; **Porter**, elected Vice-President (Business) of the Royal Society of Edinburgh, now Chair of the RSE Economy and Enterprise Committee; **Delibegovic**, elected to Royal Society of Edinburgh (RSE) Young Academy of Scotland; **Murray-G.** and **Parson** were appointed as Regius Chairs of Pathology and Anatomy, respectively; **Heisler** [2015], **Vargesson** [2019], elected Fellow of the Society of Biology; **Cruickshank**, President-Elect of European Federation of Colposcopy (2019-2022); **Dawson**, Vice-Chair, and Chair elect of the European Society of Cardiology Myocardial Function Working Group; **Forget**, President of the Belgian Pain Society; **Galley**, President of the Anaesthetic Research Society; **Murray-G.**, Pathological Society of Great Britain & Ireland -Treasurer; **Parson**, President Elect Anatomical Society, 2018-2019; **Speirs**, British Association for Cancer Research-Secretary. In total, 25 members of UoA1 staff were elected to learned society office or other significant roles.
- iii. **Academic leadership:** UoA1 staff demonstrate leadership via a wide diversity of examples such as Major conference organisation; **Bewick**, Physiology 2019; **Erskine**, Axon 2015, 2017; **Heisler**, Integrated Control [...] by Hindbrain Circuits, Cold Spring Harbor 2019; Keystone Conference, Denmark, 2017; **Platt**, Alzheimer's UK Annual Conference 2017). Other academic leadership includes; **Counsell**, Chair of Data Monitoring Committee for multicentre trial (PDCOMM)); **Morgan-P.**, Quadram Institute Bioscience, Trustee and Board member (2017-) Scottish Food Commission Member (2015-2018), Strategic Advisory Board for Scottish Government Rural Affairs and Environment (2016-17), MRC and NIHR Review of Nutrition and Human Health Research (2016), MRC-led UK Nutrition Research Partnership for health and disease (UK NRP) panel member (2018-); **Platt**, Scientific Advisor and Grant Advisory Board member, Alzheimer's Research UK (ARUK, 2013-2019); **Murray-A.**, Director of the Scotland-wide, research pooling organisation SINAPSE; **Bhattacharya-Si**, Chair, International Federation of Obstetrics and Gynaecology (FIGO) Reproductive Medicine Committee (2015-16), Chair Trial Steering /Data Monitoring Committee for NIHR trials FEMME, PRISM, ANODE, EMPOWER trials; **Speirs**, Trustee, British Association for Cancer Research (2018-), NCRI Molecular Biomarkers Advisory Group (2015-17) .

b. Co-operation and collaborative arrangements for PGR training

Staff across UoA1 contribute to PGR training at Aberdeen and in collaborative networks delivering post-graduate training. **Miller** is our representative on the BBSRC EastBio DTP management board and a member of the EU ITN SynCrop; **Delibegovic** delivers the

Aberdeen elements of EU ITN *MoGlyNet*; **Louis** leads the School interactions with the University's *Leverhulme DTP in the Sustainable Production of Chemicals and Materials*; **Lurie** is Aberdeen lead for EPSRC-funded CDT on UK Magnetic Resonance Basic Technology; **Munro** led the Aberdeen elements of EU OPATHY ITN (2015-19), and now the EU ITN *FunHoMic* network (2019-23); **Parson** led Aberdeen's element of a Motor Neurone Disease doctoral training network (Scotland CSO; 12 studentships, 2015-18); and **Platt** is co-grant holder of an Alzheimer's Society Doctoral Training Centre (2015-2020) led by Edinburgh.

4C: Contribution to the economy and society

a. Collaborative relationships with key partners and stakeholders to deliver impact:

- i. **NHS and International healthcare systems:** UoA1 staff work in close NHS partnership, co-located on the Foresterhill Health Campus. Underpinning the relationship is a University-NHS Clinical Research Board and Steering Group, a joint Research Governance unit and a *Triple Helix* liaison group linking the School, *NHS Grampian Innovation* and industry. The University and NHS-Grampian have a Data Sharing Agreement, underpinning operation of the School's *Data Safe Haven* (a protected IT space for clinical data governance). In addition to our 33 clinical academics, the School has appointed clinical SCREDS lecturers (12 in post in 2020) providing a 3-year 0.2 FTE research internship alongside clinical duties. **Cruickshank**, a clinical academic Chair within the School/UoA1, is NHS Director of Research and Development. NRS Fellowships secured by surgeons Elsberger and Massanat, intensive care consultant Kaye, and gynaecologists Maheshwari and Saraswat provide links with School researchers **Lurie**, **Broche**, **Speirs**, **Bhattacharya-Si** and Ramsay, C. (UoA2).

Nationally and internationally, UoA1 clinical research informs policy via extensive impacts on (i) NICE guidelines (e.g., Fertility problems: assessment and treatment [CG156: 2017], Heavy menstrual bleeding [NG88: 2018], Endometriosis [NG73: 2017], Ectopic pregnancy and miscarriage [NG126: 2019], obesity and weight loss (CG189: 2014)) and (ii) practice, through clinical trials (for example **Abdel-Fatah** leads a portfolio of NIHR-funded GBP5,800,000 clinical trials in stress urinary incontinence and catheterisation).

Bhattacharya-Si was NHS Research Scotland Clinical Research Champion for Women's Health and Childbearing Scotland (2015-18). **N'Dow** has a key leadership role within the European Association of Urology (EAU; Chair of its Guidelines Office Board; 2014-on). In this role he has driven the adoption of EAU urology guidelines internationally, from seven countries aligned in 2014, to now more than 75. **Bhattacharya-Si's** leadership in clinical fertility research has secured international agreement of key priorities for infertility research [PMID: 33252677]. Overall, our clinical field leadership, and the close partnership with the NHS, has led directly to a range of national and international health-care impacts including those described in our impact submission.

- ii. **Government:** The Rowett Institute is a key member of the Scottish government's umbrella organisation Scottish Environment, Food and Agriculture Research Institutes (SEFARI), linking Scottish Government research providers and in receipt of **GBP37,500,000** Scottish Government funding for nutritional science research. **Haggarty** represents the Rowett on the Scientific Advisory Committee on Nutrition (SACN), providing diet and health advice to the UK Department of Health. **Morgan-P.** was a member of the Scottish Food Commission until 2018. **Porter** was selected for the Scottish Funding Council's Research and Knowledge Exchange Committee, which has Scottish Government and economic development agency representations. The Chief Scientist for Health benefits from **Bhattacharya-Si's** expertise on his Advisory Group and **Ritchie** for public health advice, extended during the Covid pandemic.
- iii. **Industry:** **Johnstone's** nutritional science collaborative links with the retailer M&S has led to the development of the chain's *Balanced For You* food range. **Forbes**, working in an interdisciplinary collaboration with physicist Strachan (UoA18), has carried out genomics-led epidemiology of food-borne pathogens. Forbes' strong links with the British Poultry Council

and Food Standards Agency directly led to impact on food safety regulations. Rowett Institute researchers (**Louis, Walker, Scott**) have collaborative interactions with industry (Danone [**GBP380,000**]; Christian Hansen [**GBP330,000**] Mars). ECR **Rudkin** has secured a Scottish Enterprise-funded High Growth Spinout Programme and Royal Society of Edinburgh Enterprise Fellowship (**GBP4,000,000**) to advance a pipeline of targeted antibodies within spin-out *mycoBiologics*. **Wischik** and **Harrington** lead the University spin-out *TauRX*, securing over **USD300,000,000** of venture capital to pursue development therapies for Alzheimer's Disease and other dementias. Rowett Institute research into Crohn's Disease therapies using live microbiome established spin-out *GT Biologics*. Following investment from *4D-Pharma*, the company floated on the AIM stock index for **GBP16,500,000** in 2014 and has a current market capitalisation value of **GBP160,000,000**. **Gibson** is CSO for University spin-out *Sirakoss*, developing bone repair scaffolds for surgery, acquired by *OssDsign* for **GBP8,400,000** in 2020. **Porter** is Chief Technology Officer (CTO) for University spin-out *Elasmogen*, developing shark antibody derivatives for cancer and rheumatoid arthritis treatment, which has secured **GBP3,000,000** venture capital investment. The development of impact from all these collaborative interactions is supported by the University's R&I unit.

In addition to **Porter's** role as Board Director and CTO for *Elasmogen*, he holds a number of other non-executive Board positions across Scottish biotechnology. **Porter** (UoA1) and **Cruickshank** (UoA1 and NHS Director of Research and Development) are on the ONE Life Sciences board leading the delivery of the ACRD *BioHub* incubator, to be sited on the Foresterhill Health Campus. Together, the impact of UoA1's industrial engagement, and its historical and ongoing spin-out company generation, is leading the regional economic development strategy for building a life science industry in the north-east of Scotland.

c. *Relationships with users leading to impact*

UoA1 staff have established a network of interactions with research beneficiaries and patient groups that have led to national and international impact both: **N'Dow**, working with the Pan-African Urological Surgeons' Association (PAUSA), established *Horizons*, a charity working to improve the quality of health care in Gambia; **Wilson P.** led the development of a first response kit for medical emergencies using cloud technology, now spun out through MIME Technologies (2016) (ICS UoA11); **Martin K.** is Aberdeen lead for *Walk With Ease UK*, an arthritis study exploring a walking programme for sufferers in Versus Arthritis' *Living Well Programme*. Our Impact Case Studies are built on close interactions with beneficiaries, promoting understanding of the underlying challenge. **Keenan** produced key impacts on the counselling of young persons from families with Huntington's Disease through extensive Huntington's Association support group interactions; **Vargesson** developed links with support groups, parents and children affected by birth defects associated with Primodos pregnancy tests, with significant impact on a subsequent medicines safety inquiry. Our research programmes are supported by active Patient Public Interaction (PPI) groups that enable researchers to learn from the patient experience as they tailor grant proposal objectives; externally, **Maclennan** is an invited member of the European Association of Urology's new patient advocacy group.

c. *Research responses to the Covid-19 pandemic*

Exemplifying our Unit's research responsiveness in the face of an acute healthcare challenge, we have responded to rapidly changing NHS priorities and secured significant Covid-19 funding. **Porter** is working with spin-out *Elasmogen* to develop point-of-care antibody-based diagnostic kits. Collaborating with University spin-out *Vertebrate Antibodies* **Delibegovic** is developing high throughput antibody assays (Chief Scientist Office: CSO-funded). **Mutch** is working with NHS-Grampian (NHS-G) clinicians to understand aberrant blood clotting in Covid patients with Acute Respiratory Distress Syndrome (Medical Research Scotland [MRS]). **Vickers** is working alongside NHS-G clinicians to understand the protective effect of antibodies against other coronaviruses (MRS). **Black-C.**, working with NHS-G Public Health, aimed to minimise impacts on vulnerable patients; her public health expertise has been pivotal, allowing epidemiological data, supported by the Data Safe Haven and CHDS, to guide strategies protecting highly

vulnerable individuals at the height of the pandemic through monitoring and adapting Covid and non-Covid clinical care pathways. **Blana** is modelling real-time Covid-19 patient flow within the hospital by integrating real-time surveillance data (NHS-G funded). **Dixon's** (health psychology) study of the prevalence of work-related stress in critical care nurses (NIHR Recovery & Learning) looks at the long-term impact of Covid-19. **Macfarlane, Jones and Hollick** (Versus Arthritis-funded) are following-up registry and trial participants to quantify the change in mental and physical health of patients with inflammatory arthritis and chronic pain during lockdown. Finally, **Martin, Powell and Murchie** are seeking to understand the pandemic effects on the physical activity, loneliness and help-seeking behaviour of the elderly (CSO). **Bhattacharya-Si's** research has shown how IVF delivery should be prioritised post-Covid-19 (PMID: 33226080). This portfolio clearly shows how the diversity of UoA1 health science research expertise can rapidly combine to mount a multifaceted response to a health emergency.