Institution: University of Kent

Unit of Assessment: 3: Allied Health Professions, Dentistry, Nursing and Pharmacy

1. Unit context and structure, research and impact strategy

Medway School of Pharmacy (MSoP) is a vibrant and diverse school, established in 2004 in a unique collaboration between the Universities of Kent and Greenwich. The School is located at the heart of a multi-university campus (Kent, Greenwich, and Canterbury Christ Church) at Chatham Maritime, Kent. In REF2014, research by staff in the School of Pharmacy was ranked joint 8th in the UK for research intensity. An impressive 100% of our research-active staff were submitted to REF2014, and 93% of our research was judged to be of international quality, with 81% of this judged world-leading or internationally excellent. The School's environment was judged to be conducive to supporting the development of world-leading research. Since 2014, we have sought to build on this achievement through targeted recruitment of internationally recognised researchers, through supporting our early career researchers, and through a significant investment in facilities and equipment. In the REF2021 period, we have had 43 successful PhD completions, which constitutes an almost 50% increase compared to the previous REF period. Importantly, and a number of our PhD graduates are now employed as postdoctoral scientists in world-leading academic institutions such as the University of Cambridge and Yale University. Since 2014, the School has attracted over £3 million in funding, as well as access to highly specialised world-leading research facilities.

School Structure

The Medway School of Pharmacy comprises 23 FTE Category A staff, five postdoctoral researchers, and a large number of research students. Our researchers are organised into three research groups:

- **Biological Sciences (BS).** The principal research themes of this group are neuroscience, infectious diseases, cancer, and immunity, as well as renal and cardiovascular biology (Professors: Mathie, Ushkaryov; Readers: Lall, Temperton; Senior Lecturers: Sumbayev; Lecturers: Bratt, Koutsikou, Papagiannouli, Scott, Vasilopoulou, Vuono; Senior Research Fellows: Veale).

- **Chemistry and Drug Delivery (CDD).** This research group focuses on pharmaceutics, medicinal chemistry, materials sciences, and nanotechnologies (Professors: Barker; Senior Lecturers: Edwards, Hall; Lecturers: Brako, Casely-Hayford, Gubala, Lavignac, Trivedi).

- **Clinical and Professional Practice (CPP).** The focus of this research group is on the best use of medicines and supporting improvements in public health (Professors: Krska; Senior Lecturers: Corlett, Thomas; Lecturers: Bhamra, Katusiime).

Each of these groups has achieved significant research results since 2014, including: the development of opportunistic screening for atrial fibrillation by clinical pharmacists in UK general practice; the development of pseudotype viruses for testing antibodies against COVID-19 and influenza viruses; and the discovery of a fundamentally novel pathway operated by human cancer cells in order to escape host immune surveillance and a novel biomarker for blood cancer diagnosis. These results have been underpinned by high-profile publications and fruitful collaborations with researchers at world-leading institutions such as the Universities of Oxford and Cambridge, Diamond Light Source Ltd, Imperial College London, University College London, University of Basel, the Medical Centre Hamburg-Eppendorf.

Research Strategy 2014-20

When it was established, the School invested heavily (>£4 million) in newly refurbished research laboratories for biological sciences and chemistry, start-up resources for all newly appointed

research-active academic staff, and 30 bursaries for research PhD students (2007-11). This investment resulted in a vibrant and sustainable research environment that has proved a solid foundation for the School. The principal aims of our REF2014 research strategy were to build on these foundations in order to:

1. Establish an international reputation for high-quality research.
2. Secure external funding to support and sustain our research activities.
3. Develop links with local collaborators, and foster wide-ranging collaborative links, both within the UK and internationally, with academia, industry, and healthcare providers.
4. Undertake research with relevance for (and impact on) the activities of the pharmaceutical industry and healthcare providers.

Our strategy to achieve these aims was to consolidate and mature our research in BS and CDD, and to develop and grow our research activities in CPP. Our overriding aim during this period was to encourage research collaborations with other academics, industrial partners, and health-service providers. As a result of this early strategy, 100% of our research-active staff were submitted to REF2014 and 93% of our research was deemed to be of international quality. Furthermore, 81% of this was judged to be world-leading or internationally excellent. The School's environment was considered to be conducive to supporting the development of world-leading research.

The School's research strategy during the REF2021 period both extended and strengthened our previous strategy. It was closely aligned to the University of Kent's institutional research strategy (2015-20), and was based on four priorities:

1. To maintain and develop our international research reputation by producing high-quality research outputs.
2. To continue to increase external funding to sustain and support our research effort (see Section 3 below).
3. To develop and extend our wide-ranging collaborative links, both within the UK and internationally (particularly in Europe) (see Section 4 below).
4. To continue to ensure that our research has relevance for (and impact on) healthcare provision and the activities of the pharmaceutical industry, as well as the local and wider community.

The School's Research Plan is updated annually, and is used to inform individual plans for each research group and, in turn, each research-active faculty member. Within the Research Plan, targets for research income to sustain research performance within the School are set, taking into account comparisons with aspirational peer groups and externally benchmarked against high quality, successful peers. Normally, we expect a minimum of one major grant application (research council research grant or equivalent) per annum per FTE.

Research Strategy 2021-26

Over the next five years, we plan to increase our success through building on our internal collaborations across the Universities of Kent and Greenwich, and on the external partnerships described in this narrative. We will be participating in large consortia in order to attract major research funding to support and increase our contribution to world-leading research. Our aim is to further develop our successes achieved in the fields of neuroscience, virology, anti-cancer immunity and cancer diagnostics, stem cell biology, materials chemistry and nanotechnology, pharmaceutics, and the development of opportunistic screening for atrial fibrillation by clinical pharmacists in UK general practice.

We also plan to increase the number of internal interdisciplinary projects involving staff from the School, across all three research groups; for example, atrial fibrillation screening, COVID-19 research, and leukaemia diagnostic and immunotherapy of cancer projects. We will also increase involvement and collaboration with our colleagues at the Universities of Kent and Greenwich to work on crucial aspects of healthy ageing, one of our current high-priority research areas. With the recent establishment of the new Division of Natural Sciences, we will also strengthen

collaborations within researchers in the Schools of Biosciences and Chemistry, as well as with researchers in the Faculty of Science and Engineering at the University of Greenwich.

Impact Strategy

The School's research is collaborative, outward-looking, and of direct relevance to our partners across healthcare and public health, the pharmaceutical and biotechnological industries, and education. Despite our School being relatively new, our research has already had a significant impact, thanks to our close collaboration with a range of domestic and international partners outside academic, partners who not only benefit from but also inspire, support, and shape our research. Our three impact case studies demonstrate the breadth, vitality, and scope of our research across major contemporary healthcare issues, including age-related disease such as strokes and leukaemia, and responses to the COVID-19 pandemic. Evidence of impact is clear in each of our three research groups.

1. *Biological Sciences*

Our research in Biological Sciences has had major impacts for the pharmaceutical, neuroscience, biotechnology/immunology, and virology sectors. Our neuroscience research is illustrated by Mathie's work on the identification of novel potassium channel activators and the description of their mechanism of action, which has influenced the research direction of two pharmaceutical companies (Pfizer and MRC Technology) seeking to identify novel therapeutic agents for the treatment of pain. Both have invested resources in their research as a direct result of this work. Furthermore, as a direct result of our research, one such activator has been adopted in the US for use in the treatment of Birk Barel Mental Retardation Syndrome.

Significant impact has also been achieved in the field of anti-cancer immunity and diagnostics. In 2016, Gibbs, Sumbayev, and Ushkaryov discovered a fundamentally novel biochemical pathway that appears upon the malignant transformation of blood cells. For one of the components of this pathway (latrophilin), the University has filed an international patent application for its use as a novel biomarker for diagnosis and treatment of acute myeloid leukaemia. Three international, non-academic institutions have altered the direction of their work as a result of this research, and three SMEs have revised their operational procedures and invested in the applied research that derives from our research findings. Some of the world's leading hospitals, including the Medical Centre Hamburg-Eppendorf in Germany and Inselspital, Bern, have amended their patient sample screening procedures as a result of this research. The discovery received extensive international media coverage, with more than 20 news articles in publications such as *Science Daily* and *Medical Express*. In collaboration with Sparks Film production, KMTV has filmed and broadcast a documentary about this work.

Another set of projects focusing on the development of pseudotype viruses has led to significant discoveries in the area of virology and vaccine development. Serological assays used for dissecting protective antibody responses to many emerging viruses of global health importance rely on the handling of highly pathogenic viruses, meaning that only a small number of specialised bio-secure laboratories are able to undertake them. To circumvent this bottleneck, Temperton pioneered the application of safe surrogate viruses that are engineered using the repurposed core of a replication-defective retroviral vector combined with the surface glycoproteins from emerging viruses. These retroviral pseudotypes have enabled safe, sensitive immunogenicity testing of human sera in vaccine clinical trials, high-throughput screening of novel, broadly neutralising monoclonal antibody therapeutics, and international antibody standard development. This has led to the development – in collaboration with the National Institute for Biological Standards and Control (NIBSC) – of the first Ebola, MERS, and SARS-CoV2 antibodies and nucleic acid standards for the World Health Organization (WHO). Temperton's work with a spin-out company (DIOSynVax, Cambridge) has enabled the company to leverage SME-led investment in universal influenza vaccine R&D.

For further information on these three projects, see our impact case studies, led by Mathie, Sumbayev, and Temperton, respectively.

2. *Chemistry and Drug Delivery*

Significant impact has also been achieved by our research in the field of Chemistry and Drug Delivery. This are exemplified by Gubala's research on the functionalisation of 'nano-sized material' that is used in our everyday lives. As a member of the International Union of Pure and Applied Chemistry (IUPAC), Gubala has been chairing a Europe-US-Canada consortium of scientists to prepare two substantial documents (recommendations) related to the use, functionalisation, characterisation, and toxicology of nanomaterials used in human health-related applications. The consortium consists of seven world-leading scientists from institutions such as the Swiss Federal Institute of Technology (ETH) in Zurich, the National Research Council of Canada, and the Max Planck Institute for Chemistry, Germany.

3. *Clinical and Pharmacy Practice*

The interdisciplinary research of our Clinical and Pharmacy Practice group has achieved significant impact on the healthcare system. For example, Krska's work in community pharmacy public health has influenced practice locally, and has the potential to influence policy at the national level. An evaluation (led by Krska) of the NHS Health Check programme with additional spirometry testing for current and recent smokers, conducted locally by Lewisham NHS Clinical Commissioning Group (CCG), resulted in changes to how the service was commissioned and rolled out. A national study determining variation in the commissioning and delivery of public health services from pharmacies has attracted funding from Public Health England, which proposes to use the data to inform national commissioning, as well as interest from Pharmacy Voice (representing community pharmacies) and NHS England.

Pharmacists need to work with general practitioners (GPs) to deliver NHS services, yet research suggests that such collaboration requires facilitation. In 2015, Lewisham NHS CCG undertook a unique inter-professional exchange involving local community pharmacy and GP practice staff. The exchange was evaluated by Thomas. Results were disseminated via CCG and pharmacy commissioning organisations. The project was shortlisted for a Health Services Journal Patient Safety award in 2016. Discussions are now underway with the Royal Pharmaceutical Society to adopt this method of joint working between the two professional groups as good practice nationwide.

Our recent initiative led by Veale (BS) in collaboration with CPP colleagues (Corlett and Bhamra) focuses on the development of opportunistic screening for atrial fibrillation by clinical pharmacists in UK general practice. This project aims to simplify the process of screening patients for atrial fibrillation so that it can be conducted by clinical pharmacists. This will enable the rapid, reliable, robust, and affordable assessment of patients, and will lead to early detection of the potential risks of stroke, and would thus help to with the effective treatment of this life-threatening medical condition. This initiative has already attracted funding from Bayer, and in 2019-20 received the Atrial Fibrillation Association's Healthcare Pioneers Award and a Clinical Pharmacy Congress Award. For this work, Veale won the Women in Science and Engineering Emerging Technology Award in 2019.

4. *Response to COVID-19*

The School's Viral Pseudotype Unit (VPU), led by Scott and Temperton, has received £1.4 million in joint funding from the Medical Research Council and Wellcome Trust, with Professor Xiao-Ning Xu of Imperial College, London, to develop antibodies that target the novel coronavirus causing COVID-19 disease, with the aim of developing a much-needed global therapy for the disease. The COVID-19-related work of the VPU has already resulted in several outputs published in world-leading peer-reviewed journals, including *Nature Microbiology*, *Cell Reports Medicine*, *Eurosurveillance*, and *Science Immunology*. Furthermore, Temperton has been funded to run the 'neutralising antibodies' core of the Humoral Immune Correlates of COVID-19 (HICC) consortium, one of three national consortia to attract UKRI/NIHR funding.

Early in the pandemic, the School lent Molecular Biology equipment to the North Kent Pathology Department at Darent Valley Hospital (DVH) to enable the hospital to begin its own in-house COVID-19 testing and reduce its reliance on Public Health England testing pathways. In addition, experienced biological sciences staff from the school (Sumbayev and Vuono) played a significant role in developing the testing protocols, provided training for NHS staff, and were seconded to work at DVH to perform the COVID-19 testing. According to the NHS, as a result of our academics' participation, DVH was able to provide high-quality testing for all the local patients, conducting around 500 samples per day, including patients and NHS staff.

Research Integrity

The School has nurtured a strong culture of research integrity and reproducibility of our results. In line with University policy, the School has implemented three approaches to support and ensure a strong academic culture of research integrity. The fundamentals underlying research integrity are reinforced on an annual basis through information sessions delivered to all research-active staff, PhD students, and final-year MPharm students conducting their sustained research projects. The School has a dedicated Research Ethics and Governance Officer (Corlett from the CPP group) and supporting academic staff member (Koutsikou), who are responsible for organising the delivery of necessary training, as well as providing support, advice, and guidance for academic staff starting new or developing ongoing research projects. The School also operates an Ethical Approval Process that ensures timely and rigorous ethical review. The application and review process sets a clear benchmark for research integrity. The School is a member of the University's Research Ethics and Governance Committee, which is a crucial venue for sharing best laboratory and other research practices and for addressing complicated cases. It also provides external ethics review, where it is required for major (e.g. Research Council) grant applications. The University's Research Ethics and Governance Manager works within the framework described above in order to ensure timely provision of professional guidance and to share the knowledge on best practice. When commencing their studies, our PhD students are required to attend workshops on research integrity.

Open Access

We store our protocols in online repositories and, where possible, publish detailed protocols. In the laboratories, all the protocols are freely accessible to all interested academics. We are often pleased to see that the findings of our research groups are reproduced independently. Our staff are encouraged and supported to publish their research whenever possible via Green or Gold Open Access routes. The University provides support to cover the costs of Open Access publication when those costs are not covered by external research funding. All our publications are deposited in the Kent Academic Repository (KAR). Through the University's Research and Innovation Services team and the Office for Scholarly Communication, all members of staff have benefited from dedicated training opportunities on Open Access, research metrics, dissemination planning, and copyright.

2. People

Staffing Strategy

The School's staffing strategy is driven by our focus on deepening our research expertise within our three research groups, and our commitment to maintaining a balanced staff base that is international both in origins and outlook. The strategy has four principal objectives:

1. To maintain appropriate growth and balance in our staff numbers.
2. To focus on recruiting and nurturing highly skilled early career researchers (ECRs).
3. To support and develop the potential of all our staff.
4. To ensure that our research environment is conducive to the production of research of international quality, with appropriate measures in place to support the career development of our staff.

Our staff base size has grown significantly since REF2014. Currently, the School comprises 25 highly motivated research-active staff, of whom well over 50% are women (14 women; 11 men). Since 2014, the School has made a number of strategic appointments across all three of our research groups. The Biological Sciences group has grown through the recruitment of Vasilopoulou (from University College London), Koutsikou (from the University of Bristol), Papagiannouli (from the University of Cologne, Germany), and Vuono (from the University of Cambridge). The Chemistry and Drug Delivery group has appointed Barker (from University College London), who is the new Head of School, as well as Trivedi (from the University of Greenwich) and Brako (from University College London). The Clinical and Pharmacy Practice group has appointed Bhamra (from De Montfort University) and Katusiime (from University College London).

The School's research is managed by our Head of School, Director of Research, Director of Postgraduate Studies, REF Coordinator, and the administrative support team. We run an active School Research and Innovation Committee, and our Director of Research is a member of the Faculty/Divisional Research Committees at the Universities of Kent and Greenwich. The School also has a Postgraduate Research Committee that focuses on supporting our PGRs. The research activities of our academic staff are monitored by the Head of School and School Director of Research through an annual Individual Research Planning (IRP) meeting, as well as through more informal day-to-day support. IRPs are also used to ensure a fair workload distribution and the wellbeing of all our research-active staff.

Staff Development

The School's staff development plan is intended to create an open, inclusive, vibrant, and collegial working environment. We seek to ensure that all our staff have the opportunities and the support to achieve their potential and secure the appropriate career development rewards. The range of staff development opportunities available to our staff include:

- A supportive and rigorous Probation procedure.
- Timely and appropriate support for promotion via appraisal and mentoring.
- Transparent and equitable workload allocation through our Work Allocation Model (WAM).
- Support for research and conference attendance through generous individual conference support budgets, and investment in new research through our Research Support Fund (RSF). Our newly appointed staff receive a generous start-up funding in order to set up their research successfully; the School additionally provides funding support for highly innovative projects to enable academics to generate pilot data prior to seeking external funding.
- Regular study leave for all research-active staff.

Probation. All new staff undertake a probation period (normally of three years). In addition to their Probation Supervisor, ECRs are assigned a Mentor from the senior staff for the duration of their probationary period, and are actively supported to develop their short- and long-term career planning.

Appraisal and mentoring. Once they have completed Probation, staff have an annual appraisal, conducted by a senior academic from within the School. The appraisal takes the form of the University's 'Reflect, Plan, Develop (RPD) process. The RPD is overseen by the Head of School and serves the purpose of identifying the needs of each member of staff, including training, career development, and pathways to promotion. Alongside the RPD, there is also an annual research peer-review and mentoring process to monitor the quantity and quality of staff research activities and their compatibility with the School's research strategy. This process also provides staff with mentoring to help disseminate research and maximise impact, and ensures that resources are targeted appropriately and effectively.

Workload allocation. The School operates a transparent and equitable Work Allocation Model (WAM), which ensures that our staff are given credit for the range of administrative and leadership roles undertaken in a consistent manner across all career stages.

Internal funding schemes to support research. The School provides individual research allowances, with all academic staff receiving an allowance of £750 per annum. Research-active academic staff are encouraged to use their allowances to fund international conference attendance, enabling them to achieve greater exposure of their work and build international networks. The School's Research Support Fund (RSF) provides seed-corn funding for new initiatives and workshop activities to pursue new research agendas. In addition, we recently created a new Research Incentivisation Fund, to support staff who have submitted an application for external funding in excess of £100k, but were unsuccessful. These staff can apply for 1% of the award each year in order to advance the research and to enable a stronger application to be submitted on a future occasion, or for an aspect of the research to be completed. These funding streams are examples of a wide range of School initiatives intended to increase grant opportunities and support additional time for research activities. Other examples include: core funding to each research centre to underwrite the costs of major international conferences and events; a dedicated conference and workshop attendance support fund for every member of staff (£750 per annum per FTE); an External Grant Incentivisation Fund to support large and complex grant applications; and a competitive process for annual support for large collaborative research project applications. In total, since REF2014, the School has spent approximately £160k incentivising new research through these support funds for small projects, engagement, and impact-related activities. In addition, the University's Impact Fund has supported academics (with funding of up to £5k) to strengthen the impact of their research. Our staff have also been supported by the University's Small Grant Scheme (usually up to £5k). Since REF2014, 10 members of the School have been recipients of these small grants, totalling approximated £65k, which have been a springboard for bids for larger external funding schemes.

Study leave. All academic staff are entitled to apply for one term's study leave after seven terms. In addition, the School has introduced new Impact Secondment Sabbaticals to support staff in their engagement with research users and impact partners.

Recognition and reward. The success of our staffing strategy is demonstrated by the rate of promotion. Since 2014, eight current and former colleagues have been successful in promotion rounds: two to Reader (both male); five to Senior Lecturer (four female; one male); and one to Senior Research Associate (female). Some of our alumni academics were appointed at senior levels or promoted beyond the School. Examples include: Professors Peppiatt-Wildman (f), Nokhodchi (m), Apampa (f), Wildman (m), Douroumis (m), and Manfrin (m), who were appointed to professorships at leading UK universities. Drs Loo (f) and Gibbs (m) have moved into senior positions abroad, and Dr Ghafourian (f) is now a Reader at the University of Bedfordshire.

Support for ECRs. The School fully supports the Concordat to assist the career development of research staff. All new appointees to Lecturer positions are required to complete the Postgraduate Certificate of Higher Education (PGCHE) programme, which includes modules on developing as a researcher and developing as a research degree supervisor. Early career staff benefit from significantly reduced teaching loads (a 50% reduction in year 1, and a 25% reduction in year 2) to support them in developing their research profile. In addition to reduced teaching loads, our ECRs on Education and Research (E&R) contracts are allocated 250 extra hours per annum in year 1, on top of the baseline hours every academic is allocated for research (300 per annum), decreasing by 50 hours in years 2 and 3.

To augment support for early career researchers and research associate staff, the University runs an Early Career Researchers Network with branches at both the Canterbury and the Medway campuses. As well as enabling early career researchers (including final-year PhD students) from across the University to interact and form collaborations, this network also provides a forum for career advice. To complement this, the University's Graduate and Researcher College runs regular Grants Factories, a programme of grant-writing workshops for staff applying for research

funding, with each session being led by staff with significant experience and success in writing such applications.

Equality and Diversity

The Medway School of Pharmacy is committed to embedding the principles of equality and diversity across all its activities and procedures, including in recruitment and promotion processes, working patterns, teaching, and research. All our staff undertake compulsory equality and diversity training on, for example, unconscious bias awareness and diversity and inclusion in Higher Education. The School is actively engaged in the University's Equality, Diversity and Inclusivity (EDI) Network, and is represented on the forum by our EDI representative. The principles of equality and inclusivity are fully embedded across the School's research environment. For instance, EDI principles help guide the choice of external speakers to the School's research seminars. As part of Kent's preparation for REF2021, staff directly involved in the submission, including the Unit's REF Working Group members, the REF Coordinator, and the REF Administrator, were required to undertake additional EDI training as part of Kent's Code of Practice.

The School is an open, fair, and democratic workplace. Workloads are allocated on a transparent basis, with a WAM that includes credit for a range of activities, including leadership roles and PGR supervision. The School's researchers are almost equally represented with both female and male members of staff, including 14 female and 11 male academics. Our recently recruited early career researchers include highly motivated and successful female (six) and male (one) academics.

The School has won an Athena SWAN Bronze Award, and is currently preparing to apply for a Silver Award). We recognise that staff need to balance often conflicting demands with regards to teaching, research, and personal lives, and we have a strong programme to support all academics who have family/childcare responsibilities, health issues, etc., to ensure that our staff can successfully develop their research profile and academic career, with a good work/life balance. For example, Yasinska held an MRC-funded Daphne Jackson Trust Fellowship (2016-18), which enabled her to return to academic research, working in the laboratory of Gibbs and Sumbayev, and teaching (she also completed a PGCHE), following a career break to raise a family. As a result, Yasinska published several high-quality outputs, including first-author papers in *EBioMedicine*, *Nanoscale*, *OncoImmunology*, and *Frontiers in Immunology*. Her overall performance was rated as 'outstanding' by the Daphne Jackson Trust. Veale received the Women in Science and Engineering Emerging Technology Award in 2019. Since 2014, female colleagues have held the following leadership roles within the School: Director of Research and Innovation (2016-18); Director of Education (2018-present); Deputy Head of School (2017-present); and MPharm programme lead (2017-present). The current Head of School is also female (2019-present).

Research Students

Recruitment and funding. Since REF2014, 43 PhD students have successfully completed their programmes of study, this constituting a 50% increase compared to the REF2014. Over the academic years 2019-20 and 2020-21, the School will have spent over £230,000 on scholarships, a significant investment in providing opportunities to outstanding students. Almost half of our students received PhD scholarships from the School: 20 scholarships were provided by the University of Kent and one by the University of Greenwich. Some of our international doctoral students received governmental support from their home countries. For example, Benlaouer received a full scholarship from the Algerian government in order to undertake her PhD studies, which were successfully completed and also resulted in three high-profile publications in which Ouafa participated as a contributing author. Generally, our PhD students come from the UK or the EU (principally from Austria, Denmark, Greece, Italy, Portugal, and Spain). We have also recruited students from Algeria, Nigeria, and Thailand.

Training and supervision. Our PhD students and postdoctoral researchers receive excellent training from our academics. Every PhD student in our School has a supervisory team consisting

of at least two supervisors. If a supervisor has not yet successfully supervised a PhD student to completion in the UK, they are paired with an experienced second supervisor, who acts as the supervisory team chair and who provides guidance and mentoring as necessary. Our PhD students meet with their supervisors at least weekly, to ensure that the necessary help and advice are provided. PhD students also prepare monthly summaries (reviewed and approved by supervisors) and also available to be monitored by the School's Director of Graduate Studies. We operate supervisory panels to ensure that PhD students are being provided with the necessary support and guidance. These panels evaluate the students' research performance at progression points. The Director of Graduate Studies is present at all the supervisory panels.

In the first term of their research programme, PhD students attend regular training workshops organised by the University's Graduate and Researcher College. Our PGRs are strongly encouraged to attend both national and international academic conferences, and to present their work as oral communications and posters. Often, this is funded externally by the meeting organisers or via learned society travel awards, and sometimes by the School. For example, Wyzsynski (who completed his PhD in 2015) obtained a highly competitive scholarship from the European Academy of Allergy and Clinical Immunology (EAACI), covering registration, accommodation, and travel costs, to attend the EACCI Annual Congress, where he delivered an oral presentation. Gonçalves Silva (who completed her PhD in 2017) won travel fellowships from both the European Federation of Immunological Societies and the British Society of Immunology, and successfully presented her work at corresponding meetings.

In most cases, individual PhD or post-doctoral research projects form part of wider research programmes run by national and international research consortia or collaborating School academics. Examples include Sakhnevych (PhD student) and Yasinska (postdoctoral researcher), whose work was jointly supervised by Sumbayev, Gibbs, and Ushkaryov, and was part of the programme run by the European Research Consortium (led by Sumbayev) focusing on anti-cancer immunity and including academics from the UK (University of Essex, Diamond Light Source Ltd), and Europe (University Hospital, Bern, Switzerland; University Medical Centre, Hamburg-Eppendorf, Germany; European Commission Joint Research Centre, Ispra, Italy; and Institute for Research in Biomedicine, Bellinzona, Switzerland). Both Yasinska and Sakhnevych were first authors on six high-profile research outputs published by the consortium. Steponenaite (a former PhD student and currently a research associate in the School) worked under the supervision of Lall and Mathie on an ambitious project conducted in partnership with Translational Molecular Neuroscience Group from the Weatherall Institute of Molecular Medicine, Nuffield Department of Clinical Neurosciences, and the University of Oxford. The project was successfully completed, resulting in a high-impact research output published in the world-leading interdisciplinary journal *Nature Communications*.

Publications, recognition, and rewards. Our PhD students have been very successful in the dissemination of their work. During the REF2021 period, this has included a number of publications in highly ranked peer-reviewed journals and oral/poster presentations at national/international academic conferences. Outputs have included primary-author publications with their supervisors in world-leading scientific journals such as: *Proceedings of the National Academy of Sciences of the United States of America* (PNAS), *Nature Communications*, *Nature Microbiology*, *Nanoscale*, *PLOS Medicine*, *Journal of Biological Chemistry*, *Cellular and Molecular Life Sciences*, *Small*, *Cell Research*, *British Journal of Pharmacology*, *OncoImmunology*, *EBioMedicine*, *Cellular and Molecular Immunology*, *eLife*, *Vaccine*, *Frontiers in Immunology*, *Journal of Controlled Release*, *Cell Reports Medicine*, *Journal of Physiology*, and *Annual Reviews in Pharmacology and Toxicology*.

Onward employment. We are particularly proud that the vast majority of our PhD students successfully continue to develop their research through academic or industry careers. Many are employed by world-leading universities and research institutions, or by industry and funding agencies. Examples include: Yale University, Wellcome Trust, King's College London, University College London, Imperial College London, Karolinska Institute (Sweden), University of Cambridge, National Research Council Canada, Abbott, Lonza Group (Basel, Switzerland), GSK (Siena, Italy),

St Jude's Children's Hospital (USA), DIOSynVax (Cambridge, UK).

3. Income, infrastructure and facilities

Income

Since REF2014, the School's staff enjoyed considerable success in securing external funding to support their research, with external research awards being in excess of £3 million. Our strategy for generating research income has been to diversify, increase, and internationalise grant awards across all three of our research groups, with a strong focus on collaborative working (see Section 4 below). Since REF2014, we have: increased the number of grant applications submitted; diversified and internationalised the range of targeted funders; supported applications for large and complex grants; and used School and University research funds as a springboard for future large grant capture (see Section 2 above). As a result, our academics have been successful in attracting competitive national and international research funding. This includes highly competitive major awards from the Medical Research Council, Wellcome Trust, and Cancer Research UK (ca £1.5 million in total). Funding has been secured both by well-established researchers and by early career researchers winning New Investigator Awards (£489k) and Fellowships (ca £170k in total).

Major innovation grants were secured from both LifeArc and Pfizer. Additionally, the equivalent of over £500k was obtained through access being awarded to high-profile modern state-of-art research equipment, examples including funding from the Diamond Light Source Synchrotron facilities, and the high-resolution transmission electron microscopy of the European Commission Joint Research Centre. Over £200k was secured through the recruitment of highly skilled self-funded PhD students and postdoctoral fellows. This included governmental sponsorship (for example, PhD studentships funded by the Algerian and Thai governments), and a highly competitive postdoctoral fellowship from the European Academy of Allergy and Clinical Immunology. Our researchers also attracted over £150k in funding from overseas funding agencies (for example, Swiss Cancer League), which included the salary of postgraduate researchers who spent some of their research time (up to five months) in the School's laboratories, as well as insurance and funding for consumables.

Infrastructure and Facilities

The School benefits from newly equipped state-of-the-art research laboratories operated by the BS and CDD groups. The facilities include: tissue culture facilities designed for handling cell lines and primary human cells; FACS facility; Li-Cor Odyssey imaging techniques; multiphoton, phase contrast, and fluorescent microscopy; multifunctional colorimetric and flurorometric facilities, and Molecular Biology laboratories. Each of our three research groups also has its own communal annual budget of £25,000 per annum, which enables us to give our research groups access to core laboratory consumables (for example, tissue culture plasticware and basic laboratory chemicals).

Since REF2014, we have invested around £500k into our infrastructure in order to purchase highly sensitive equipment, such as the new model Li-Cor Odyssey machine, a FACS machine, and a multiphoton microscope. These core facilities have enabled us to produce high-quality research with a significant impact (outlined in the Section 1 above). Furthermore, the School's researchers have benefited from regular access to synchrotron (operated by Diamond Light Source Ltd, Didcot, UK) and to transmission electron microscopy and surface plasmon resonance techniques provided by the European Commission Joint Research Centre (Ispra, Italy).

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

Collaborations

The examples of our research activities given in Section 1 above, and also in our three impact case studies, demonstrate that networking and external collaborations are key components of the School's research strategy. We believe that these collaborations are critical to our development. All of our researchers collaborate with colleagues in academia and industry, both in the UK and

abroad, with over 40 collaborators in the UK, over 50 collaborators in Europe, and a number of collaborators in the Australia, Guatemala, Iran, Israel, New Zealand, Singapore, Thailand, Uganda, and the United States. Our strategic partnerships and collaborations include: world-leading universities such as the University of Oxford, University of Cambridge, Imperial College London, University College London, University of Basel, Inselspital Bern, University of Florida, and Ben-Gurion University; major research centres such as Diamond Light Source Ltd, European Commission Joint Research Centre, and Cambridge Brain Bank; and major industrial partners such as DIOSynVax and Blue Water Vaccines.

Alongside these various external collaborations, we also have a number of research partnerships between the School's two partner universities, Kent and Greenwich, including those between Lall and Douroumis (University of Greenwich) on 3D printing, and between Mathie and Firaz, who won a Leverhulme Trust Major Research Project Grant as joint PIs. Members of the School are also involved in a number of interdisciplinary projects, in particular with the University's School of Biosciences. In addition, our staff are contributing to the University's new collaborative Signature Research Themes (SRTs); for example, Bhamra is working closely with colleagues across the University on the Migration and Movement SRT.

As a School of Pharmacy, we value our strong connections to local healthcare professionals, the pharmaceutical industry, and the recently established Kent and Medway Medical School (KMMS). All researchers in the School are members of KentHealth, the University's 'one-stop shop' for health and social care expertise. This has already extended our links with local healthcare providers such as Medway NHS Foundations Trust, Kent and Canterbury Hospital, East Kent Health, and a number of local pharmacies. We have also established links with several animal healthcare agencies, including the World Organization for Animal Health (OiE), the Animal Health Trust, the Animal and Plant Health Agency (APHA), the Pirbright Institute, the Federal Research Institute for Animal Health (Germany), and the National Equine Centre (Ireland), as well as Public Health organisations such as Public Health England, the National Institute for Biological Standards and Control (NIBSC), and the World Health Organization (WHO).

A large number of our research projects are undertaken in collaboration with industry, particularly the pharmaceutical, biotechnology, and immunodiagnostics industries. The School has active collaborations with over a dozen pharmaceutical companies, from large multinationals to SMEs, including Pfizer, GlaxoSmithKline, Merck, Novartis, Biovendor, Humabs, Ablynx, Boost Technologies, Aptum Biologics Ltd, Oxley Hughes Ltd, SipCo Ltd, Avacta Life Sciences Ltd, Izon Science, Alk Abello, Discovery Biomed Inc, Colorcon, Charles River, Takeda, Galleon Pharmaceuticals, Chiralabs, Biogen, DIOSynVax, Blue Water Vaccines, and Laserchrom. These collaborations with industry have led to joint applications for funding, including Horizon 2020 and SME-led Innovate UK bids. One example is Gubala's research (described in Section 1 above). As a member of IUPAC, Gubala chairs a Europe-US-Canada consortium of scientists preparing two crucial recommendations related to the use, functionalisation, characterisation, and toxicology of nanomaterials used in human health-related applications.

Our Honorary Professor of Cardiopulmonary Sciences (Ghazwan Butrous) is a major contributor to the School's research. He is currently President Emeritus of the Pulmonary Vascular Research Institute, a global organisation with over 1,000 members.

Contributions to the Research Base, Economy, and Society

Since REF2014, we have set out to enhance the research profile of the School within our scholarly networks, both nationally and internationally, in a number of ways.

1. *Participation on grants committees*

Since 2014, Medway School of Pharmacy staff have served on grant review panels or as grant reviewers for over 30 funders, including BBSRC, MRC, EPSRC, Wellcome Trust, Diabetes UK, Royal Society, Leverhulme Trust, BHF, NIHR, Research for Patient Benefit, BUPA, NC3Rs, the Health and Medical Research Fund (HMRF) Hong Kong, Research Foundation Flanders, Belgium

(FWO), Kidney Research UK, Cancer Research UK, Bloodwise, Deutsche Forschungs-gemeinschaft (Germany), Agence Nationale de la Recherche (France), Förderung der Wissenschaftlichen Forschung (Austria), Telethon Fondazione (Italy), Swiss National Science Foundation, Irish Reseach Council, and Commonwealth Scholarship Commission.

2. Panel and committee memberships

Since 2014, our staff have served, and in some cases are currently serving, on international research committees. For example, Gibbs has served on a special emphasis NIH/NIAID panel. Mathie is currently serving on the BBSRC Pool of Experts and Alzheimer's Research Trust Referee Panel. Thomas contributes to the activities of the International Olympic Committee as the Clinical and Pharmacy Practice expert. Barker is a member of the MHRA's Advisory Board on the Regulation of Homeopathic Products.

3. Editorial boards and journal editorships

Our staff have served on the editorial boards of more than 10 journals. For example, Ushkaryov is currently a member of the editorial board for the *Journal of Biological Chemistry*. Mathie and Veale are editors of the widely used *Concise Guide to Pharmacology* (the 2019-20 edition has been cited over 800 times since publication in December 2019). Mathie is an editor of the *International Journal of Biochemistry and Cell Biology*. Sumbayev is on the editorial board of *Scientific Reports* (Nature Publishing Group) and *Biomolecules* (MDPI). Gibbs is one of the leading editors of *Inflammation Research* (Springer-Nature). Krska is an editor of the *International Journal of Pharmacy Practice*. Sumbayev is a member of the editorial boards of *Scientific Reports* (Nature Publishing Group) and *Biomolecules*. Temperton is an editor for *Vaccines* and *Access Microbiology*. Hall is a member of the editorial board of *Reactive and Functional Polymers*. Scott is an editor for *Virus Genes*. In addition, our staff have reviewed papers for more than 90 academic journals in the REF2021 period.

4. Conferences and lectures

All Medway School of Pharmacy researchers regularly communicate their research to a wider audience as invited speakers, invited contributors, or plenary speakers at national and international conferences. This includes major events such as the annual meetings of American Neuroscience Society (Koutsikou, Lall, Mathie) and the European Academy of Allergy and Clinical Immunology (Gibbs, Sumbayev). Butrous was a Chair and keynote speaker at the Infection and Pulmonary Vascular Disease Symposium, 14th Pulmonary Vascular Research Institute World Congress, Lima, Peru, 2020. Sumbayev was invited speaker and section chair at the 24th World Congress on Advances in Oncology (Athens, 2018) and the 23rd International Symposium on Molecular Medicine (Bangkok, 2019). As a former Research Fellow of the Alexander von Humboldt Foundation (Germany), Sumbayev receives ongoing financial support to attend academic conferences in, and research visits, Germany. He was an invited UK delegate at the Humboldt Colloquium 'Moving Forward – The UK-German Research Network in a Changing World' (Oxford, UK, 2018). Scott presented invited talks at the Influenza Symposia held in 2014 and 2016 at the University of Oxford. Temperton delivered a keynote address at the Institute of Bioscience (IBS), University Putra Malaysia, funded by the BBSRC.

Our early career researchers have also demonstrated a high level of activity as invited/plenary speakers at prestigious international conferences and even as conference organisers. Vuono was the organiser and chair of RIGeast 2019 – the 1st East of England Research Interest Group Parkinson's Conference, which took place at Sanders Hall, University of Cambridge. Papagiannouli delivered an invited talk at the EMBO Symposium, in Heidelberg, Germany, in 2014, and at the Joint Workshop of the Japanese (JSDB) and German (GfE) Society of Developmental Biologists, in Kyoto, Japan, 2019. Vasilopoulou gave a plenary lecture at the 5th International Symposium on Thymosins in Health and Disease, in Washington DC, in 2017. Bhamra delivered an invited lecture about the quality of practitioners and prescriptions, and the

relevance to clinical studies, at the International Congress on Traditional Asian Medicine (ICTAM), Kiel, Germany, in 2017.

5. *Public engagement*

The School has a robust public and media engagement strategy, which extends beyond traditional academic publication routes to support wider public engagement with our research. We work actively with the University's press office, as well as with the Office for Scholarly Communication, to ensure that the research accomplishments of our staff are reported to the public and covered in the media. A number of our publications have received wide media coverage in the REF2021 cycle. For example, Lall's and Mathie's research was published in *Nature Communications* (2020); while the work of Veale, Corlett, Bhamra, and Mathie published in *PLOS Medicine* (2020) was covered in news articles across the world. The research findings published by Sumbayev, Ushkaryov, and Gibbs in *EBioMedicine* (2017), *Nanoscale* (2018), *Cellular and Molecular Immunology* (2018), and *Frontiers in Immunology* (2019-20) was highlighted in over 20 news articles across the world, and was identified as a fundamental discovery in the press release published by the British Society for Haematology. The follow-up work of this group was presented in a documentary produced by KMTV in 2019 (screened in 2020). Their discoveries are also included into the teaching programmes on anti-cancer immunity internationally, including at the University of Basel and University Hospital Bern (Switzerland). Most recently, our ongoing work on COVID-19 led by Scott and Temperton's research being the subject of widespread media coverage and public dissemination.

6. *Impact on society and the economy*

Our three impact case studies and the examples provided in Section 1 above demonstrate the wide range of impacts that our researchers have achieved in the healthcare, pharmaceutical, biotechnology, and immunodiagnostics sectors. Highlights include:

- Temperton and Scott have developed a robust and safe system based on pseudotype viruses that allows research on highly pathogenic and dangerous viruses to be conducted in ordinary bioscience laboratories, reducing costs and increasing efficiency. Examples of such viruses include influenza, Ebola, and the COVID-19 coronavirus.
- Veale, Corlett, Bharmra, and Mathie are successfully developing opportunistic screening for atrial fibrillation to be conducted by clinical pharmacists in UK general practice. This will significantly reduce the costs and increase the efficacy of the efforts associated with highlighting the risks and significantly reducing the number of stroke cases in the UK and possibly worldwide.

Our sustained contribution to society and the economy has been underpinned by our successful strategy to significantly increase income and maintain long-term collaborative partnerships with industry and other HE institutions. It reflects our success in recruiting and nurturing outstanding staff across all three of our research groups, and in providing a supportive and collegial research environment in which staff at all stages of their career can flourish.