Institution: University of Kent

Unit of Assessment: 5, Biological Sciences

a. Overview

Research in Kent's School of Biosciences focuses on essential molecular processes involved in inheritance, metabolism and protein synthesis. Following a major strategic review post RAE 2008, the School now has 25 principal investigators of which 11 were appointed in the last three years. Research is divided into three main themes, Molecular Microbiology, Protein Science and Biomolecular Medicine, each led by a senior professor. Research is underpinned by three major research facilities supporting cell imaging, biomolecular sciences and protein NMR, each run by their own facility manager. We adopt a multidisciplinary approach to problems encompassing the subjects of biochemistry, genetics, biotechnology and biomedical research from within the School, and broader expertise from staff across the University in engineering, computer science, materials and mathematics. An example of this is our Centre for Molecular Processing (CMP; see section b for further details). Such approaches naturally involve colleagues from industry and result in impact outside of academia, involving a strong commitment to translational research and commercial application. The School's research strategy is designed to enhance the research environment through the purchase of new equipment, provision of studentships, facilitation of national/international collaboration and provision of quality training and mentoring. Research in the School during this period has, for example, challenged widely accepted notions of the evolution and function of mitochondria (**Tsaousis**-1), unravelled one of nature's most complex biochemical pathways (**Warren**-4), elucidated the evolutionary relationships between mammalian and avian genomes (**Griffin**-2,3) and identified the first virally-encoded scission protein (**Rossman**-2). Our strategy has resulted in a sustainable School focusing on high quality research together with training and support for early career researchers and PhD students with a clear pathway for professional development.

b. <u>Research strategy</u>

Evidence of strong research plans: In 2008/9 the University undertook a major strategic review of the School, underpinned and reinforced in part with a £4 million commitment from the University (including £450,000 development funding to support the appointment of additional Professors) and in part with external funding. The objectives of the strategy have been fully implemented. One of our key activities has been to **increase the number of research active staff** in the School, at both senior and ECR level. In this respect the School has appointed three new chairs (**Michaelis,** Brown,D and **Robinson**), ten new ECRs as lecturers (**Busciano, Gourlay, Mollapour, Mulvihill, Rossman, Shepherd, Tsaousis, von der Haar, Wass** and **Xue**) and taken on two ECRs as fellows (**Frank** and **Mead**). These staff have strengthened our three research theme groupings of **(1) Molecular Microbiology, (2) Protein Science** and **(3) Biomolecular Medicine**. They have also been incorporated into our multidisciplinary **Centre for Molecular Processing (CMP)** and helped expand the experimental skill base.

We have **invested in our research facilities** through purchasing state-of-the-art equipment, putting in place an accelerated equipment replacement programme and refurbishment of the building. This has allowed us, during the last three years, to upgrade our electron, atomic force and fluorescent microscopes, purchase new live cell-imaging microscopes, electrospray and MALDI systems and to initiate a major refurbishment of our 600MHz NMR facility, the latter funded in part by a grant of £400k from the Wellcome Trust. We have introduced protein crystallography and bioinformatics into the School through the **strategic appointment** of Brown,D formerly Head of Structural Biology in Pfizer, and **Wass**, following completion of his FEBS Fellowship in Madrid.

Increased **interaction with the biotechnology and pharmaceutical sectors** has been achieved by developing the CMP and the appointment of an Industrial Liaison Officer. As a result the School is involved with 15 major companies (see section e) and has industrial, LINK, TSB and KTN projects associated with them.

The **postgraduate experience has been enhanced** through provision of more PhD studentships, training programmes and modules. The School works closely with the University's new Graduate School to ensure the provision of University-funded postgraduate PhD scholarships (currently 5 per year) and we continue to attract significant numbers of (mainly BBSRC) CASE studentships (3-4 per year).

Responsiveness to national and international priorities and initiatives: The University Research Office ensures the School is informed of external developments via weekly emails and bulletins. Our research committee organises regular meetings to encourage staff to respond to calls and helps coordinate some of the larger bids. The responsiveness of the School can be gauged from its lead, over the last three years, in coordinating bids for two different BBSRC-sponsored Networks in Biotechnology and Bioenergy (NIBB), a Centre for Synthetic Biology and four BBSRC-LoLa applications.

Effective mechanisms for the development, promotion and dissemination of research: All staff are encouraged to attend a series of staff workshops such as the "Grants Factory" and the "Early Career Researcher Network" which are presented by senior academics, and which include visits from funders such as Wellcome, Leverhulme, BBSRC and the EC. To improve the quality of research proposals we implemented an Internal Peer Review System in 2010 to allow colleagues in Biosciences to discuss their plans in an open forum three times a year. This system has now been adopted throughout the University. Collectively, these approaches are major contributing factors to the success of our new ECRs gaining external funding – all have received grant support since their appointment with **Xue, Buscaino** and **Rossman** winning 'new investigator' project grants. The School has a sustained track record of effective interactions with the biotechnology, biopharmaceutical and molecular diagnostic sectors leading to translation of the research into the commercial domain (see *REF3a*). Our Industrial Liaison Officer is also the University's Innovation & Enterprise Unit's (KIE) Technology Transfer Manager and facilitates interactions between the School and industry. A Faculty of Science Strategic Research Fund (£40k in 2013-14) and a School Research and Enterprise Fund (£20k in 2013-14) provide a further source of funds which researchers can source to help purchase small pieces of equipment, facilitate conference travel, forge international collaborations and pump-prime new research areas. KIE provide funds of £20k per annum to the School for entrepreneurial activities (e.g. Ideas Factory). PIs are encouraged to publish their research in high impact international journals and are supported in the publicity of their findings by a pro-active press office that disseminate the findings via a broad range of outlets. Publicity is also achieved through the School's website, a blog (http://blogs.kent.ac.uk/biosciences) and professionally produced newsletters.

Research groupings – rationale and achievements: Research in the School is grouped into three synergistic themes:

1. Molecular Microbiology (Co-ordinator: **Tuite**) encompasses researchers interested in "Yeast Molecular Biology (The Kent Fungal Group)" and "Microbial Pathogenesis." These groups work together to address focussed questions of genetic control, cellular morphology and microbial pathogenicity. The Kent Fungal Group (www.kentfungalgroup.com) studies key cellular processes in the yeast cell such as protein synthesis, apoptosis, protein folding and cell division. The group also use yeast to explore the molecular basis of human disease and ageing. A further focus is on the transcriptional and post-transcriptional control of bacterial gene expression by phase variation, and the role of morphology in the influenza virus lifecycle. ***Significant achievements***: the importance of conformational flexibility in prion propagation in living cells (**Tuite**-4), the first experimentally calibrated genome-wide computational model of mRNA translation in a eukaryote (**von der Haar**-1), how dysfunctional mitochondria promote ROS production from the endoplasmic reticulum (**Gourlay**-4**),** that post-translational modifications profoundly affect the molecular chaperone (Hsp90) function (**Mollapour**-3,4), the activation of the type 1 fimbrial adhesin of *E. coli* by regulators (**Blomfield-**3) and the elucidation of the process of nitric oxide-detoxification in *Campylobacter* (**Shepherd**-2).

2. Protein Science (Co-ordinator: **Geeves***)* is composed of research groups interested in "Industrial biotechnology and synthetic biology" and "Protein form and function". The groups work together to address specific challenges to understand better molecular processes such as a) defining biological mechanisms that underpin synthesis and bioprocessing of metabolites and protein-based pharmaceuticals; b) folding, structure, function and regulation of proteins of medical relevance; and c) dynamic aspects of molecular motors and cytoskeletal proteins. Protein NMR, X-ray crystallography, AFM and live cell imaging skills are embedded in these groups. Research combines science and engineering and involves design and construction of new biological functions and systems, plus the optimisation of metabolic pathways. The group has many industrial contacts (e.g. Lonza Biologics, UCB, Pfizer, Medimmune, GSK) and works closely with control

process engineers and computational modellers. ***Significant achievements***: the engineering of recombinant organelles in *E. coli* (**Frank**-1**),** a molecular explanation of two isoforms of human myosin found in heart tissue (**Geeves**-4), the underlying processes associated with the cold-shock response (**Smales**-1-3), the discovery of novel TatA-type complexes (**Robinson**-1), the modeling of monoclonal antibody production in mammalian cells (**Mead**-1), determination of the relationship between the structure and function of PDI (**Williamson**-1,3) and other ER proteins (**Howard**-1,3) and new insights on the mechanism of amyloid fibril assembly and breakage (**Xue**-1,2).

3. Biomolecular Medicine (Co-ordinator: **Griffin**) includes researchers involved in "Cell biology, cancer targets and therapies" and "Cytogenomics and bioinformatics". These groups work collectively to focus on research that has practical and therapeutic applications in prognosis, prediction, diagnosis and treatment of disease. This includes exploiting the interface with genomics to study genome evolution, selection, structure, inheritance and reproductive medicine. ***Significant achievements***: a novel means of enhancing the effectiveness of Herceptin as an inhibitor of breast cancer cell growth (**Gullick**-3**),** new methods to allow protein docking to predict protein-protein interactions (**Wass**-2), how Raf represents a critical drug target in cytomegalovirus replication (**Michaelis**-3), the discovery that tropomyosin acetylation determines actin polymer dynamics and function (**Mulvihill-**4), the elucidation of the molecular basis of rectification at electrical synapses (**Phelan-**1), the discovery of the key steps leading to the assembly of heterochromatic repressive domains (**Busciano**-3) and a universal approach for the detection of genetic disease in IVF embryos (**Handyside**-1).

The development, promotion and dissemination of an active research culture. An annual 'research away-day' facilitates discussion of longer-term policies relating to research and enterprise and ensures staff engagement with the development of the research and enterprise strategy. A research seminar programme attracts internationally recognised external speakers (e.g. Paul Nurse, Tim Hunt, Philip Cohen) and a weekly 'Forum for Innovation, Research and Enterprise" focuses on presentations by the School's staff and students plus sessions on enterprise, outreach and new technologies. To assist in the career development of postdocs, there is an annual "Best Research Paper" competition judged in "grants committee style" by the postdoc-lead group. For significant pieces of research news, the media office issue press releases that are placed on the Biosciences blog, web site and newsletter. The School has an active outreach programme and regular public lectures that allow staff to integrate with the local community. For example, through interactions with local teachers, **Tuite, Warren** and **von der Haar** have helped pioneer the "*Authentic Biology Project*" (www.authentic-biology.org) introducing genuine research projects into the curriculum that has had nationwide impact. The active research culture is supported by the School through the provision of funds for the annual maintenance of its major equipment (£120k) as well as a further £200k per year for new/replacement equipment.

Interdisciplinary/multidisciplinary research: The School upholds the principle that progress in research will be achieved primarily through the exploitation of multidisciplinary approaches. This commitment is demonstrated by the School-led establishment in 2009 of the Centre for Molecular Processing (www.kent.ac.uk/stms/cmp/index.html). The CMP (directed by **Smales**) provides research and training with the remit to link research with industrial application. Already this has led to an enhancement of our understanding of specific cellular and molecular processes and has allowed researchers to predict, model and manipulate them as evidenced by three industrially associated patents and a recent LINK award with Lonza Biologics to **Smales** and **Warren**. The ideas and technology embodied in different disciplines are being employed on core CMP projects through the formation of new collaborative teams including bioscientists, computer scientists, engineers and chemists. The establishment of the CMP ensures that both multi- and interdisciplinary approaches are easily facilitated within the School and provides a strong interface with leading international companies (Lonza Biologics, GSK and Pfizer) as well as local enterprises (including the Discovery Park in Sandwich). The recently established Computational Biology Centre (CBC www.kent.ac.uk/stms/cbc/index.html), a collaboration between the Schools of Computing and Biosciences, encourages inter-faculty collaboration through the application of computer-based algorithms and datasets to address biological questions.

c. People, including:

i. Staffing strategy and staff development

Staffing strategy: The School aims to appoint exceptionally talented bioscientists within its three

main focussed areas of research. Since Jan 2008 the School has made 11 new appointments. Three have been at the Chair level to provide additional research leadership in the key strategic areas of structural biology, cancer biology and industrial biotechnology, respectively. All new staff are given generous set-up packages and are provided with refurbished laboratory and office space, equipment and consumable allowances, and a PhD studentship. Since Jan 2008 two staff retired and three others left the School representing a net gain of 6 new academic staff and in keeping with our strategic plan to increase the overall number of research active staff.

An important element of the School's staffing strategy is to recruit independent Research Fellows and since 2008 the School has supported two high quality young research fellows (**von der Haar, Gourlay;** both now permanent academic staff), two Daphne Jackson Fellows (Marziano 2008-10 and Oliver 2010-12), and currently hosts two 'Early Career Leverhulme Fellows (**Mead** 2012-14; **Frank** 2013-15). All independent research fellows are provided with laboratory space, facilities and authoritative academic leadership and guidance to ensure they can develop their research programmes and professional careers.

Concordat and career development: The School fully supports the principles of the 'Concordat to Support the Career Development of Researchers'. Staff regularly participate in the Researcher Development Programme (www.kent.ac.uk/graduateschool/skills/pgrd.html) which encourages more junior staff to develop their skills and abilities for a future in research.

Equality and diversity. The School has an Athena SWAN working group who ensure advancement and promotion of the careers of women. In 2011 the School hosted a one day Stacey Symposium entitled 'Kent women in Biosciences' with 8 female alumni describing how their careers have progressed since leaving the School. The University has submitted for an Athena SWAN bronze award and the School aims for a Silver award by 2015.

Sustainable staff structure. Through its strategic teaching and research appointments, enabled by a strong budgetary position, the School has a good mixture of experience and youth among its research active staff (10 Profs, 3 Readers, 4 SLs, 9 Lecturers and 2 Research Fellows), two of whom are submitted to UoA3 (Brown, D and Baines). The staffing structure is therefore well balanced in terms of experience and has an even distribution between its research themes.

Development and support of research work of staff. All staff are formally appraised annually by a senior academic while each January the Head of School and Director of Research also hold individual meetings with all academic staff to discuss their research progress and plans and to set research and enterprise targets. The School runs a transparent, formula-driven workload allocation model (WAM) that monitors an individual's contributions to teaching, administration and research on an annual basis. All academic staff qualify for study leave or leave of absence to pursue research and scholarship objectives for periods of up to 12 months. During the REF review period 20% of staff took periods of study leave or leave of absence to develop research projects. The School also provides financial support (up to £20k per annum) for the research and scholarship activities of all staff, providing up to £1000 to individuals for conference registration and travel, open access publishing costs and short-term research visits.

Research career development: The School has adopted the new university appraisal system (the 'Reflect, Plan and Develop' scheme) which highlights opportunities for training and development for all staff. The scheme encourages staff to improve their performance, while maintaining compatibility with nationally and internationally-recognised standards of excellence. In 2013 the University received the European Commission "HR Excellence in Research" Award which acknowledges our alignment with the principles of the European Charter for Researchers and Code of Conduct for their recruitment.

Support for early career researchers (ECRs). The University offers professional development courses for ECRs (including fixed-term contract postdocs) to provide skills training and support in working towards a career as an independent researcher. A cross-Faculty ECR Network provides a monthly forum in which ECRs can discuss issues and concerns about establishing an independent academic career. For early career appointees, teaching and other duties are kept to the minimum for the first 2 years of appointment (≤ 20 teaching contact hrs/yr) to allow them to develop their research programmes. Newly appointed academic staff without a formal teaching qualification take the University's PGCHE course which includes modules relating to research management and support. New members of junior academic staff are assigned a tutor (by the University) and a

mentor (by the School) to provide support during the early stages of their careers. Junior academic staff co-supervise their first PhD students jointly with an experienced senior member of staff.

ii. Research students

Doctoral research training. The School is committed to the professional training of its postgraduate research students. Since Jan 2008 the School has taken on average 14 new home and overseas PhD students per year and has an 85% 4 year completion rate during that period. Postgraduate students, funded by Research Councils (BBSRC, MRC), CASE, University awards and overseas agencies, are given ample opportunity to develop both their research and personal skills. This includes an online Postgraduate Development Folder, which sets out the training courses available and allows for the recording of training events attended and various monitoring reports. All postgraduates attend a two week Induction Course that provides training in health and safety issues, research ethics and personal and transferable skills. The latter element incorporates a BBSRC-supported Media Communications Skills course (see p29: www.bbsrc.ac.uk/web/FILES/Publications/bbsrc_business_winter_2010.pdf). Newly registered students also attend workshops on key practical skills throughout the year. All research students have their own designated workspace in modern state-of-the-art laboratory facilities under the management of their project supervisor and are subjected to a rigorous monitoring procedure as outlined in the University's Code of Practice for the Quality Assurance for Research Programmes of Study. This provides research training elements in line with the 'Researcher Development Statement' developed by Vitae, coupled with the requirements and the recommendations of the Roberts Report. Supervisors/co-supervisors, together with an independent 'supervisory chair', are responsible for carrying out a structured progression monitoring programme for each student, which involves the submission of short monthly online reports, annual reports and the presentation of oral and poster communications to the School.

Research student culture. Communal facilities in the School provide ample opportunity for frequent contact between research students in both a formal and an informal setting. All postgraduates participate in a two day Annual School Symposium during which all final year PhD students give an oral presentation, while year 2 PhD and MSc students present posters. Postgraduates develop their teaching skills through demonstrating and supervising undergraduate projects, and are given the opportunity to participate in our wide range of outreach activities. Year 2 PhD students attend a 5-day course in 'Biotechnology and Public Affairs' led by industrialists and all postgraduates attend the School's weekly seminar series. Postgraduates have representatives on all of the School's major committees. All PhD students attend and fully participate in regular research group meetings and journal clubs and are given the opportunity of attending at least one major international and two national conferences, where they are expected to present a poster or talk on their research. The School runs a Dragons Den that encourages postgraduate entries and has entered teams in the Biotechnology YES competition (www.biotechnologyyes.co.uk) and the Global Skills Award (www.kent.ac.uk/graduateschool/skills/programmes/gsa.html), experiences which are designed to improve awareness and employability.

CASE awards. Between 2008-13 the School has received 22 CASE awards from the BBSRC representing ~25% of all PhD students in that period. CASE awards have involved 9 different sponsoring organisations including Lonza Biologics, UCB Celltech, Medimmune, Pall Life Sciences, Cairn Research, TgK Scientific and GSK. In addition to their required industrial placement, CASE students also participate in the annual CMP conference, which brings together academic and industrial scientists to present and discuss current and future industrial research challenges. Through the CMP, CASE students are also encouraged to engage with industrialists outside of their immediate project.

d. Income, infrastructure and facilities

Research Income: Funds awarded for our research from all sources, over the period Jan 2008 to July 2013, totalled £14 million which equates to over £100k per annum per research active FTE. New grant awards announced since July 2013 amount to £2 million with the majority being awarded to staff appointed in the last two years including **Buscaino** and **Rossman,** two early career researchers. In addition the award of two BBSRC-Networks in Biotechnology and Bioenergy (NIBB) led by **Smales** and **Warren** respectively was announced in November 2013. Strategic reinvestment of indirect costs have been made into seed funding, core research facilities and infrastructure as described elsewhere. The School's research income has been derived from a

variety of sources including research councils (BBSRC, EPSRC), charities (Wellcome Trust, Leverhulme Trust), government agencies (e.g. TSB), European funding and industry. Examples include a BBSRC LINK award to **Smales** and **Warren** (£517k), joint cross-institution BBSRC awards to **Warren** (with Oxford, £800k and with Queen Mary, £850k) and **Tuite** (with Manchester, £329k), a Wellcome Trust Programme award to **Geeves** (£1.74M) and Wellcome Trust Equipment award to **Howard, Williamson, Geeves, Warren** and **Smales** (£457k), a TSB award to **Griffin (**£441k); an EU-funded Initial Training Network grant to **Robinson** (€583k); and a full industrially-funded award to **Smales** (Lonza Biologics £971k).

Research infrastructure and facilities: Since 2008 over £3 million has been spent on the School's research infrastructure at the heart of which are the state-of-the-art and centrally managed research facilities. The staff, servicing, and upgrade costs of the facilities are built into the School's annual budget with a significant level of cost recovery through grants and contracts. This ensures long-term stability in service provision. Additional income is generated from contracts carried out for external academic and commercial organisations. A senior scientific officer and building supervisor ensure equipment and laboratories are well maintained. Facilities and infrastructure are available to all postgraduate students and researchers with training provided by the managers.

Biomolecular Sciences Facility (Manager: Howland) provides a range of separation technologies (including FPLC, HPLC, capillary electrophoresis, GC-MS), spectroscopy (CD, UV-visible and fluorescence) and mass spectrometry (ESI and MALDI-ToF/ToF). Other in-house services available include peptide synthesis, protein identification and characterisation, and glycan analysis.

Protein NMR Facility (Manager: Rowe) houses a 600MHz NMR spectrometer that includes a 4th channel deuterium decoupler and NMR probe for the detection of ^{1}H, ^{13}C, Co^{2+} and ^{15}N. An upgrade in 2011 included a new console and cryoprobe. Computation for NMR data processing and analysis is supported via ten UNIX workstations and the facility supports and tests packages for the BBSRC-funded Cambridge University Collaborative Computing Project for NMR.

*Cell Image Analysis Facility (*Manager: Brown,I) has confocal microscopy, transmission and scanning electron microscopy and atomic force microscopy. This facility also supports two state-of-the-art fluorescent microscopes and a Video Microscopy Suite for fully automated live cell imaging. The facility carries out analysis of microbial and mammalian cells, biomaterials and biofilms.

The School also houses several other specialised facilities including a *Fast Reaction Kinetics Facility* based in the **Geeves**' laboratory which includes stopped-flow, quenched-flow, flash-photolysis and pressure-jump systems. Every two years this laboratory hosts a highly successful EMBO Practical Course "Application of Transient Kinetics Methods to Biological Macromolecules". The **Warren** laboratory houses an *Anaerobic Handling Facility* that allows for anaerobic extraction and spectrophotometric analysis of metabolites and proteins and includes a specialised crystallisation unit. A *Class 3 Containment Facility* is available for the manipulation of pathogenic bacteria and viruses and facilities for the handling of radioactive sources are also available. Facilities for *tissue culture and fermentation* of mammalian cells are maintained in a number of laboratories within the School. A Science Supplies Facility (stores) maintains stocks of regularly used consumables and undertakes all ordering and deliveries.

Cross-HEI shared or collaborative use of research infrastructure: The Protein NMR Facility is widely used for cross-HEI collaborative projects e.g. Warwick (Freedman), the Institute of Cancer Research/Barts/London School of Medicine and Dentistry (Marshall), and the University of Oulu (Ruddock). The Biomolecular Science Facility also supports collaborative projects e.g. mass spectrometry used by colleagues at Kings College London (Blower), University College London (Bracewell) and Newcastle University (Martin and Montague). Members of the School are also involved in cross-HEI sharing of collaborative research infrastructure. For example, **Howard** and **Williamson** regularly acquire time on the MRC Biomedical NMR Centre 700 and 800 MHz instruments through a peer reviewed process.

Significant benefits in kind. Through its strong links with industry the School has gained benefit in kind for both equipment and access to industrial expertise and resources. For example, for a recent Link grant (BBSRC, **Smales/Warren**) Lonza Biologics provided matched funding of benefits in kind of over £700k. The equipment manufacturers Bruker and Varian have provided probes for the NMR facility to the value of over £50k. Employees of Cangenix, a biologics company formed in

2011 and housed within the School, have provided training in Baculovirus expression and access to cell disruptors, isothermal titration calorimetry (ITC) and some thermal shift assay analysis to the value of £25k per annum.

Policy and practice in relation to research governance: The School adheres to all University of Kent, RCUK and national and international policies and practices on research governance. The University's Research & Ethics Governance Officer guides and advises researchers on good research practice, ethical review and regulatory requirements. All research projects are subjected to ethical and health and safety evaluation before commencement with a designated a Health and Safety Officer and an Ethics Officer. We encourage open access publishing with financial support available to investigators to allow this and require that primary data is stored securely for a minimum of ten years. All new postgraduate students and research staff are made aware of the importance of good scientific practice and adherence to appropriate policies.

e. Collaboration and contribution to the discipline or research base

Indicators of wider influence to discipline or research base: Across the School there are numerous examples of our wider contribution to the research base. For example, in 2008 **Tuite** was one of 50 UK bioscientists selected to participate in the Bioscience:Biomillions event at HM Treasury in London to "demonstrate and celebrate the social and economic impact" of BBSRC-funded research. **Gullick** was Chairman of the *Council of the European Association for Cancer Research* (2008-2010). **Tuite** is Chair of the Eukaryotic Division of the *Society for General Microbiology* (2013 to date). **Griffin** is President of the *International Chromosome and Genome Society* (2011 present) and a Committee member of the Preimplantation Genetic Diagnosis International Society (since May 2012). **Howard** was executive chair of the BBSRC-funded CCPN (2010-2012). Brown,D successfully led the proposal for the final Synchrotron beamline at DIAMOND that supports the UK Macromolecular Crystallography community and now heads the recently refunded CCP4 framework. Since 2007, the School has organised and run the nationally recognised annual Wain Medal (www.kent.ac.uk/bio/news/wain/index.html) awarded to an outstanding young scientist working at the biology-chemistry interface.

Participation in the peer review process: Warren and Brown,D are current core members of BBSRC committee D. **Blomfield** served as a core member of panel B during this review period while **Griffin** and **Tuite** are members of the BBSRC Pool of Experts. **Smales** served for 5 years on the BBSRC/EPSRC BRIC Steering committee. **Warren, Geeves** and **Tuite** have served on the Royal Society Overseas Awards committee, **Tuite** is a current member of the Leverhulme Trust Advisory Panel and **Howard** is member of The Royal Society Newton International Fellowships panel. **Warren** has chaired the Finnish Academy 'Bio1' and FinSynBio panels. **Geeves** is a member of grants panels for Italian (Cinecca) and French (ANR) funding bodies. **Smales** is a member of the CBSB panel for Science Foundation Ireland (SFI).

Fellowships and relevant awards: Warren held a BBSRC Professorial Fellowship (2008-13), **Tuite** has a Leverhulme Fellowship (2012-14), **Griffin** held a BBSRC career development fellowship (2008-10) and **Mulvihill** (2012-16) and **Smales** (2013-17) hold Royal Society Industrial Fellowships. The School currently hosts two Leverhulme Trust Early Career Development Fellows (**Mead**, **Frank**). **Warren** was the Krebs Lecturer (University of Sheffield, 2012) and the Drummond Lecturer (Queen Mary, 2010). **Griffin** was shortlisted for the Times Higher "project of the year" in 2011. **Smales** was offered a Wolfson Research Merit Award (2013).

Journal editorships: Geeves is an editor for *J Biol Chem* and *PNAS,* **Tuite** was an Academic Editor for *PLoS One* (2009-12) and currently is on the Editorial Board of *Yeast* and *Prion*. **Tuite** & **Gourlay** are founding members of the Editorial Board of a new 'Open Access' journal *Microbial Cell*, to launch in 2014. **Smales** is an executive editor for *Biotech Letts*.

Academic collaboration: All staff are involved in national and international collaborations and collectively they share over 100 different collaborators across five continents. The School has many examples of jointly funded national projects with UK universities including Oxford, Cambridge, Warwick, Manchester, Queen Mary, Durham, Newcastle, UCL, Southampton, Leicester and Aberdeen. Active international collaborations include research projects with Innsbruck, ITQB (Lisbon), Cork, Univ Georgia, Max Planck Institute for Plant Breeding Research (Cologne), Whitehead Institute (Boston) and BOKU (Vienna). Over 85% of staff have given lectures at international conferences and half of our staff have organized or acted as chairs in such

meetings; e.g. **Shepherd** organizer, Tetrapyrrole Discussion Group meeting (Canterbury, 2013), **Smales** and **Mead** organizers, Translation UK meeting (Canterbury 2013), **Tuite**, Chair, Jacques Monod Conference (Roscofff, 2010); **Geeves**, Principal Organizer, *Workshop on Muscle and Motor Proteins* (Alpach, 2011, 2013); **Gourlay, Tuite** and **von der Haar**, co-organizers, 8th*International Meeting on Yeast Apoptosis (*Canterbury, 2011*)*; **Warren,** Chair, Gordon Research Conference on Tetrapyrroles (Newport RI, 2014) and **Griffin,** Chair, International Chromosome Conference in Manchester (2011).

Extent of collaboration and integration with external bodies: The School has extensive collaboration and integration with external bodies involving all academic staff. Examples include interactions and collaborations with the NHS (via **Mühlschlegel**) and KentHealth, the University's 'one-stop-shop' for health and social care expertise in research, training and innovation with the regional NHS. **Griffin** has strong links with the London Bridge Fertility Clinic (including a joint TSB grant). **Geeves** has on-going collaborations with US colleagues with NIH funding. **Smales** has extensive links with industry including fully-funded research projects (Lonza Biologics, Pfizer) and as project partners on grants and studentships (Lonza Biologics, GSK, Medimmune, UCB Celltech, Fujifilm Diosynth Biotechnologies, Pall Life Sciences). Other major industrial interactions include **Howard** (GSK), **Mulvihill** (Cairn Research), **Gourlay** and **von der Haar** (Novozymes), **Griffin** (CytoCell and JSR genetics), **Warren** (GSK) and **Robinson** (UCB Celltech). Via the CMP, staff are able to gain advice from industrial advisors, including Professors John Birch (formally Chief Scientific Officer at Lonza Biologics) and Simon Campbell (formally Pfizer, Sandwich), to help develop industrial interactions. The School, via the CMP, also has an on-going interaction with the HealthTech and Medicines KTN via BioprocessUK to introduce academics to industrialists and foster collaborations. The School has played a leading role in helping to establish the BBSRC Networks in Biotechnology and Bioenergy (NIBB) and has academics as PI (**Smales**) or CoI (**Warren**) on two separate and recently funded applications in the areas of "bioprocessing" and "metals in biology" respectively.

Responsiveness to national and international priorities and initiatives: Through recent appointments (e.g. **Robinson**) and the establishment of the CMP, the School has positioned itself to readily develop new research programmes in industrial biotechnology, a major priority area for research councils and EU funding programmes. The development of the CMP as a cross-disciplinary Centre has been driven by our own research strengths and in response to on-going priorities and initiatives. **Robinson** is deputy co-ordinator of a multi-site Marie Curie ITN on algal biotechnology and a single site ITN on bacterial cell division. Through notification by the faculty funding officer, academic staff are encouraged to respond to national and international priorities where appropriate and the work associated with development of proposals and responding to initiatives is recognised in individual staff members work allocation model.

Mechanisms to promote collaborative research within the academic community and users of research: The Centres for Molecular Processing and Computational Biology promote collaborative research with the academic community and end users. The CMP runs an annual conference attended by academics and industrialists, focussed upon cross-disciplinary industrial biotechnology (from the fields of biology, biochemistry, chemistry, engineering, mathematics, computing) to showcase research at Kent and to engage with key end users. The CMP and CBC run informal sessions and presentations to foster interactions within the University and with end users. Funds provided by the Faculty of Sciences have been used to help foster and develop new academic collaborations, for example, a faculty PhD studentship has been used to instigate research into the development of novel TB drugs with a group led by Clifton Barry at NIH, Bethesda. Other examples include **von der Haar**/Computing, Engineering; **Tuite**/Statistics, **Blomfield**/Computing, **Smales**/Statistics, Engineering and **Griffin**/Anthropology. The School sponsors a yearly Dragon's Den event to help promote ideas on developing collaborative science that can be placed in a commercial context. Visitors and collaborators are strongly encouraged to use the School's facilities. Researchers from Lisbon, Oxford, Cambridge and Innsbruck have used **Warren**'s anaerobic handling facility and **Geeves** has had numerous academic visitors from the USA, Italy, Germany and the UK, in addition to hosting the biannual residential EMBO Practical Workshop on Transient Kinetic Methods in Biological Macromolecules last held in 2012.