Institution: Cardiff University

Unit of Assessment: 5

a. Overview

Biosciences at Cardiff is based in the College of Biomedical and Life Sciences and is led by its Director, MRC Prof **Ole Petersen FRS FMedSci**. Biosciences is currently (2013) ranked in the top 100 global universities for life sciences by the Shanghai Jiao Tong University ARWU.

Research Groups and Substructure: As a result of the appointment of Prof Petersen in 2010, Biosciences was re-organised into four major research sections, which represent the building blocks of research and provide staff, postdocs and research students with their primary research affiliation. There is considerable intellectual exchange within and between the four sections:

- **Molecular Biosciences** led by Prof **James Murray** focuses on the molecular mechanisms underpinning biological function.
- **Neuroscience** led by Prof **Vincenzo Crunelli FMedSci** pursues a broad range of neuroscience research, spanning molecular, through cellular and systems to behavioural neuroscience.
- **Organisms and Environment** led by Prof **Michael Bruford** aims to understand the ecological, behavioural and genetic consequences of environmental change on biodiversity at all levels.
- **Pathophysiology and Repair** led by Prof **Alan Clarke**, focuses on molecular disease mechanisms and the processes that drive repair and regeneration, spanning biochemistry, cell biology, molecular genetics and signal transduction.

b. Research strategy

i. Achievement of Strategic Aims for Research during the Assessment Period

In our RAE2008 submission several objectives were stated for the coming period, including the establishment of:

- A Cancer Research UK Centre
- A Stem Cell Centre
- A Centre for Brain Imaging
- A Centre for Climate Change
- A Wellcome Trust 4-year PhD Programme in Integrative Neuroscience

All the above objectives were met and our strategy remains to foster and develop Centres of Excellence.

- The **Cancer Research UK Centre** was established in Cardiff in 2010 as a partnership between Cancer Research UK, Cardiff University, Velindre NHS Trust and Cardiff and Vale University Health Board. Example grant: 5 year programme grant to Clarke (CRUK).
- The **European Cancer Stem Cell Research Institute** (ECSCRI) was established in 2011 to explore the 'Cancer Stem Cell' hypothesis and create new collaborations both across the University and with UK and international partners. Example grant: 5 year programme grant to Smalley (CRUK).
- The **Neuroscience and Mental Health Research Institute** (NMHRI) was established in 2011 with the objective of becoming an internationally-recognised centre of excellence in the field of neuroscience and mental health. Example grants: Wellcome Trust Strategic Award (Crunelli, Harwood, Li), Wellcome Trust Programme Grants (Crunelli and Davies), MRC Programme Grants (Fox and Dunnett).
- **The Sustainable Places Research Institute (PLACE)** was established in 2011 and its vision is to provide a new basis for sustainability science, aiming to push the boundaries of traditional sustainability research and finding solutions to the challenges of diminishing resources and climate change. Example grant: NERC Biodiversity Thematic Programme Grant to Durance, Ormerod, Bruford, Vaughan and Weightman.
- The training of new researchers has been developed by the award and recent extension of the **Wellcome 4-year Integrated Neuroscience PhD** programme.

ii. Details of Significant Changes to the Unit in the Period

Key Appointments

- **Prof Yves Barde (Member of EMBO)**, from the Biozentrum at the University of Basel, joined the School in 2013 as Sêr Cymru (Star Wales) Research Chair in Neurobiology (£4M Welsh Government grant). An important aim of this programme is also the recruitment of independent junior scientists. **Dr Stéphane Baudouin (**from the Biozentrum in Basel), whose research focuses on the molecular basis of autism, has already joined Yves Barde's Programme as a Group Leader.
- **Dr Thomas Connor** from the Sanger Institute, who works on the fundamental aspects of pathogen evolution. This appointment has also enhanced and extended bioinformatics provision to researchers in the School.
- **Dr Emyr Lloyd-Evans** from the University of Oxford as a RCUK Fellow, who works on the role of lysosomal function in neurodegenerative diseases.
- **Prof Jim Murray** from University of Cambridge, in 2008. The Murray group is heavily supported by BBSRC grants and leads a European network (ERA, Systems Biology of the Shoot Apical Meristem (SY-STEM). Prof Murray's research group has major research interests in plant cellular development and molecular biotechnology.
- **Prof Ole Petersen FRS FMedSci** and his group from the University of Liverpool, including **Dr Oleg Gerasimenko.** The establishment of this research group in Cardiff, now working on the pathophysiology of pancreatitis, led to successful renewals in 2012 of the 5-year Petersen/Gerasimenko MRC Programme Grant and the associated MRC Professorship for Prof Petersen.
- **Dr Neil Rodrigues** recruited from Harvard in 2013 to the ECSCRI. Dr Rodrigues' research focuses on understanding the haematopoietic stem cell niche and its role in both normal and neoplastic development.
- **Dr Matt Smalley** in 2012 from the Institute of Cancer Research, London. Dr Smalley was a key recruit to the ECSCRI whose research strives to identify what drives differences between various types of breast cancer and what drives differences between individual tumour cells within a breast cancer.

Strategic Interdisciplinary Appointments

The School of Biosciences encourages high-level interdisciplinary collaborations, nationally and internationally. Ongoing successful collaborations between Clarke-**Ehrmann** (University of Duisburg-Essen), Murray-**Scheres** (Utrecht University)/ **Helariutta** (University of Helsinki) have resulted in strategic part-time appointments in the School. The Nobel Laureate **Huber** (Max Planck Institute of Biochemistry) has maintained/developed his collaboration (Jones, Petersen) and continues to hold a part-time appointment in the School. **Gray** (University of Southampton), and **Li** (Hammersmith Hospital, Imperial College) are new joint appointments with Medicine based in NMHRI.

International Scientific Advisory Board (ISAB)

An **International Scientific Advisory Board** was established in 2010 to provide advice on strategic direction and to provide a means of communicating our established and emerging research to the international bioscience community. ISAB is chaired by **Prof Kim Barrett** (University of California, San Diego), who is currently President of the American Physiological Society and is composed of a distinguished group of internationally recognized scientists including **Prof Anders Björklund** (University of Lund), **Prof Charles Godfray** FRS (University of Oxford) and **Prof Arthur Konnerth** (Technical University Munich). The first ISAB meeting in February 2011 was associated with a symposium on '*Frontiers in Biological Sciences'* and the March 2013 ISAB meeting was associated with an international symposium on '*Signalling in Physiology and Pathophysiology'*.

iii. Strategic Objectives for the next 5 years

The strategy is to develop further key initiatives established in the REF period, the most significant being the establishment of the University Research Institutes (URIs) and Centres of Excellence as well as the Sêr Cymru Research Group:

The European Cancer Stem Cell Research Institute (ECSCRI)
ECSCRI aims to address the topical concept that cancer stem cells exist in tumours and drive tumour growth and relapse and offer new therapeutic targets for treatment**. Prof Alan Clarke** (Pathophysiology and Repair) is Director of this Institute in which the University has invested an initial £3.1M for 2011-2015. The ECSCRI secured a substantial number of research appointments (6 Research Group leaders) concurrent with occupation of the new £30M Hadyn Ellis Building in summer 2013. Supported by its patron, **Sir Terry Matthews**, its Advisory Board includes **Jean Chrétien**, Professor **Sir Martin Evans FRS** and **Lord Kinnock.** The ECSCRI held its inaugural international conference at the Celtic Manor Resort in July 2013.
Example outputs: Molyneux et al *Cell Stem Cell* 2010 (Smalley), Hogan et al *Nature Cell Biology* 2009, Homer et al *Science* 2009 (Gui).
Future Objectives:
- To test the usefulness of the cancer stem cell hypothesis in a range of different tumour types.
- To create a critical mass of researchers working on the molecular mechanisms of a range of solid and haematopoietic cancers.
- To develop a cancer stem cell platform for drug development.
- To develop a rolling fellowship programme to attract key junior personnel in this field.

Cancer Research UK Cardiff Centre
Cancer work in the Pathophysiology & Repair section was strengthened by the establishment of the Cancer Research UK Cardiff Centre, directed by **Prof Alan Clarke**. The CRUK Centre in Cardiff is a collaborative network of leading scientists, doctors and nurses from across the City: Cardiff University, Velindre NHS Trust and Cardiff and Vale University Health Board. Teams at the Centre focus on research into leukaemia, bowel, breast and urological cancers. In November 2013 the CRUK Centre was successful in obtaining funding for an additional three years.
Example outputs: Ashton et al *Developmental Cell* 2010 (Clarke), Kreuzaler et al *Nature Cell Biology* 2011 (Clarkson)
Future Objectives:
- To expand the clinical and non-clinical cancer PhD training programme.
- To expand phase I clinical activity.
- To establish a network between several Centres based on development and use of organoids.

Sêr Cymru
In the Autumn of 2012, the Welsh Government launched its Sêr Cymru (Stars Wales) programme: a £50M fund over 5 years to improve research capability in each of the three Grand Challenges (advanced engineering and materials, life science and health and low carbon, energy and environment), by attracting outstanding, world-class science researchers to Wales. In June 2013, the Welsh Government announced the appointment of **Prof Yves-Alain Barde** (the discoverer of BDNF and pioneer of the neurotrophin field) as Sêr Cymru Research Professor in the School of Biosciences. Prof Barde joined the School in September 2013. Cardiff University was awarded £4M, by the Welsh Government, to appoint Professor Barde, which was matched by Cardiff University investment.
Example outputs from Yves Barde's group: Deogracias et al *PNAS* 2012 (Barde), Dieni et al *Journal of Cell Biology* 2012 (Barde), Nikoletopoulou et al *Nature* 2010 (Barde), Matsumoto et al *Nature Neuroscience* 2008 (Barde)
Future Objectives:
- The use of embryonic and re-programmed stem cells to better understand the molecular basis of brain development as well as of diseases of the nervous system.
- The role of brain-derived neurotrophic factor (BDNF) in conditions such as depression and its possible use as a relevant biomarker in accessible human samples.
- Work on well-tolerated substances diffusing into the brain able to meaningfully increase BDNF levels to prevent neurodegeneration.
- Studies on the role of BDNF in brain growth.

Neuroscience and Mental Health Research Institute (NMHRI)

The Institute's mission is to translate basic research findings into a better understanding of psychiatric disease mechanisms, classification and diagnosis. Initial University investment of £3.1M for 2011-2014 brought together researchers from the Schools of Biosciences, Psychology, and Optometry, co-located in two floors of the £30M Hadyn Ellis Building (opened in 2013). In particular, the potential of human stem cell biology in treatment of these disorders will be explored by **Profs Meng Li** and **William Gray** (both joint appointments with Medicine). **Profs Vincenzo Crunelli, Adrian Harwood** and **Frank Sengpiel** (Neuroscience research section) are key members of NMHRI.

Example outputs: Lorincz et al *Neuron* 2009 (Crunelli), Jacob et al *Neuron* 2012 (Fox), Hardingham et al *Neuron* 2008 (Fox), Ranson et al *PNAS* 2012 (Sengpiel), Kisiswa et al *Nature Neuroscience* 2013 (Davies) and O'Keefe et al *Nature Neuroscience* 2008 (Davies)

Future Objectives:

- To define a new biology of neurodevelopmental disorders and identify novel biomarkers of these conditions.
- To address the full spectrum of mental health problems - from childhood to old age: including ADHD and autism, epilepsy, schizophrenia, Alzheimer's and Parkinson's.
- To raise awareness and challenge stigma through public dissemination and engagement programmes and the National Centre for Mental Health.
- To train the next generation of clinical and non-clinical scientists to take on the interdisciplinary challenges posed by neurological and psychiatric disorders.

MRC Group

The Secretory Control Research Group led by **MRC Prof Ole Petersen FRS FMedSci** and **Dr Oleg Gerasimenko** (Reader) moved to Cardiff in 2010 and had its funding (MRC Programme Grant and MRC Professorship) renewed for the period 2012-2017 (£2.3M). The plan is to establish the molecular mechanism by which acute pancreatitis is initiated and progresses to chronic pancreatitis (and potentially to pancreatic cancer) and to establish an effective treatment for the disease.

Example outputs: Gerasimenko et al *PNAS* 2009, 2011, 2013, Ferdek et al *Curr Biol* 2012 (Gerasimenko/Petersen)

Future Objectives:

- Following publication of the Group's proof of principle (isolated mouse cells) for a rational pancreatitis therapy based on CRAC channel blockade (*PNAS* 2013), experiments on whole animals (mice/rats) as well as on isolated human cells are planned.
- To establish the mechanisms by which acute pancreatitis becomes chronic.
- To understand the physiology and pathophysiology of the pancreatic stellate cells, which secrete a cancer-promoting matrix.

Arthritis Research UK Biomechanics and Bioengineering Centre at Cardiff

In 2009 Arthritis Research UK selected Cardiff University (led by Biosciences [**Profs Caterson, Duance**]) to become its UK Centre of excellence in biomechanics and bioengineering. Partnered investment (ARUK, £2.5M/CU, £7.5M) established a focus for collaborative translational research between biomedical scientists and practitioners applying expertise in engineering, bioscience, genetics and imaging to arthritis research. The mission is to create a step-change in the treatment, diagnosis and rehabilitation of arthritis via interdisciplinary research investigating relationships between mechanical loading, joint function, pain and inflammation. The Centre has been invited by Arthritis Research UK to apply, non-competitively, for a further 5 years of funding.

Example outputs: Bondeson et al *Arthritis & Rheumatism* 2010 (Hughes/Caterson), Wainwright et al *Arthritis & Rheumatism* 2013 (Hughes/Caterson)

Future Objectives:

- To explore the potential to reverse joint degeneration by altering joint biomechanics.
- To identify specific indicators of rapid onset of degenerative joint disease after acute injury and develop interventions to prevent osteoarthritis development and progression.
- To develop multivariate interdisciplinary tools to predict joint replacement outcomes and better direct appropriate interventions.

Sustainable Places Research Institute (PLACE)
PLACE aims to provide a new basis for sustainability science by pushing the boundaries of traditional sustainability research and finding solutions to the challenges of diminishing resources and climate change. PLACE brings together scholars and research clusters across a wide range of academic disciplines at Cardiff. The initial University investment was £2.1 million for 2011-2014, and Biosciences is one of the nine Schools involved. PLACE has secured a major NERC award for the project DURESS (Diversity of Upland Rivers for Ecosystem Service Sustainability) This £3M project (Dr Durance and Profs Ormerod & Bruford) forms part of the £13 million NERC Biodiversity and Ecosystem Services Sustainability (BESS) initiative and is the first concrete research platform for unification of macro and microbiological environmental science envisaged when the Organisms and Environment Section was formed.
Example outputs: Zhan et al *Nature Genetics* 2013 (Bruford), Claesson et al *Nature* 2012 (Marchesi), Pereira et al *Science* 2013 (Bruford)
Future Objectives:
- To focus on recruiting staff working on the biology of whole organisms and their roles and interactions in changing ecosystems with special reference to quantifying the dynamics of ecosystem services in the face of changing patterns of land use and global climate change.
- To integrate established methodologies from the natural, physical and social sciences, enabling a new understanding of the interrelations between ecology, society and economy.

Danau Girang Field Centre
In 2008 the School established a collaborative research and training facility in Sabah, Malaysia, led by **Dr Benoit Goossens**. The Centre is owned by the Sabah Wildlife Department and co-managed by Cardiff. It is a focus for biodiversity research; the main purpose being a better understanding of the mechanisms of degraded forests and adaptation of the fauna to a highly fragmented ecosystem. Malaysian grant income paid directly to the Centre (>£1M since 2010) supports the School's research work in Sabah. Cardiff University and The Sabah Wildlife Department (SWD) have recently signed an agreement to continue this collaboration for a further ten years.
Example outputs: Arora et al *PNAS* 2010 (Goossens), Jalil et al *Molecular Ecology* 2008 (Cable/Bruford/Goossens)
Future Objectives:
- To develop research using new technology such as satellite tags and conservation drones.
- To establish the Wildlife Health, Genetic and Forensic Laboratory in collaboration with EcoHealth Alliance and Sabah Wildlife Department.
- To produce State Action Plans on 5 charismatic species by 2016-17

Sugud Islands Marine Conservation Centre
In June 2013 the Sugud Islands Marine Research Centre (SIMRC) was established on Billean Island, within the Sugud Islands Marine Conservation Area (SIMCA), on the east coast of Sabah. This new initiative marks a further collaboration between Cardiff University, the Sabah Wildlife Department and Reef Guardian. The Centre will undertake advanced marine ecosystem science and will enhance research and conservation efforts.
Future Objectives:
- To develop high-level research on coral reef and island ecosystems.
- To develop marine conservation programmes.

iv. Mechanisms for the Development and Promotion of Research
An encouraging environment for high-quality research has been established. Research in Biosciences is developed and promoted by a combination of mechanisms:
- Access to state-of-the-art shared equipment (for example, MRI and PET imaging, transmission electron microscopy).
- Access to well-maintained animal house facilities and refurbished specialist transgenic unit.
- Dedicated recently refurbished laboratory space (Barde, Murray, Petersen).
- New research buildings in the Hadyn Ellis building (ECSCRI, NMHRI) and extension to the Sir Martin Evans building (state-of-the-art seminar facilities).
- Development of strategy by Research Committee meetings with research policy discussed

during Academic 'Away Days' and Academic Plenary meetings.
- Return of a proportion of overheads on external research grants to PIs to bridge-fund research posts, purchase equipment and fund conference travel.
- Use of annual appraisal to monitor research performance and internal peer review of grant applications by at least one senior academic.

v. Mechanisms for the Dissemination of Research

This is a significant element of research strategy. In addition to web additions and press announcements, two dedicated Innovation and Engagement Officers, working at both local and European level have been appointed. Examples of success in Engagement include the Wellcome Trust funded 'Cardiff Brain Games', International Fascination of Plants Day, interest groups (RSPB, Naturalist Society) and patient/carer groups (Parkinsons UK, Arthritis Research UK, Cancer Research UK), media output (BBC's *Rhys to the Rescue* and *(Dr) Rhys Jones Wildlife Patrol, Discovery Channel's Biggest and Baddest*)

vi. Responsiveness to priorities outside the School

In response to EU calls, Biosciences was successful in securing funding for three FP7 cooperation projects, with a value of circa £3M. In addition, researchers in Biosciences were also successful in securing two Marie Curie Intra-European Fellowships and two Marie Curie Initial Training Networks. Strategy has developed in response to external priorities of the major funding bodies such as securing the Arthritis Research UK Biomechanics and Bioengineering Centre and Cancer Research UK Centre, in national competition. In Wales a similar approach led to the Sêr Cymru Research Chair appointment of Yves Barde mentioned above and to a National Research Network funding under the Sêr Cymru initiative. Responding to University strategic priorities the School is a partner in three University Research Institutes: ECSCRI (which it leads); NMHRI and PLACE.

Through our well-developed Knowledge Exchange activities, we have a number of partnerships with commercial enterprises and our partnership with GE Healthcare is an exemplar of this. The Danau Girang Field Centre monitors the sustainable co-existence of a burgeoning palm oil and tourism industry within the rainforest and has led to conservation action plans being adopted by the Malaysian Government and global engagement with public interest groups.

c. People, including:

i. Staffing strategy and staff development

Staffing strategy in the School is shaped by key requirements for: 1) high level of research quality; 2) broad expertise across the full range of the Life Sciences from whole ecosystems to molecular biology; 3) a healthy balance between senior staff and early career researchers; 4) effective succession planning. Staffing strategy and staff development operate within Cardiff University's Investors in People Framework. University commitment to supporting the career development of its researchers was recognised by attaining the European Commission HR Excellence in Research Award in 2010. Accreditation was renewed in 2012 in recognition of the University's progress in implementing the Concordat to Support the Career Development of Researchers.

Early Career Researchers (ECRs)

A priority for Biosciences has been the recruitment of ECRs and the School has been successful in attracting a number of these (**Baudouin, Connor, de Navascues, Gui, Hogan, Lloyd-Evans, Perkins, Rodrigues, Sanchez-Vilas, Young**) some with their own named fellowships and young investigator awards (e.g. Royal Society, Wellcome, MRC, Marie Curie, RCUK). ECRs have their own forum and are placed in a formal mentoring programme. An Independent Researcher Secondment Scheme has been established to give promising research staff (**Deng, Hole, Jones, Liddiard, Lin, Reed, Zhan**) exposure to the full breadth of the academic role by engaging in learning and teaching and developing an independent research portfolio. Secondees receive training and may be involved in small group teaching, lecturing, workshops, laboratories, assessment, examining and seminars. Cardiff University was one of six institutions shortlisted for the "THE Outstanding support for early career researchers" award (2010), which recognises the University's provision of comprehensive and integrated support to help early career researchers develop their transferable and career development skills.

Academic Promotions and Staff Development. In the REF period, 25 staff were promoted within the School: seven to Professor, nine to Reader and nine to Senior Lecturer. In the past three years, the number of female Professorial staff has increased threefold. The School utilises the University Study Leave and Leave of Absence Policy to enable staff to take extended periods of leave and where time away from normal contracted duties is likely to enhance promotion prospects, staff are supported to take study leave.

The School is committed fully to implementing the principles of the *Concordat to Support the Career Development of Researchers*. Following feedback from staff within the School, the following areas have been prioritised for increased consideration:

- **Communication.** Objectives and expectations of staff are widely communicated through formal appraisals and research group meetings. Academic Plenary meetings provide a forum for staff to be updated on latest developments in the School and to provide feedback.
- **Leadership and Mentoring.** A formal Mentoring Programme is well established. Cardiff is also a member of the Women in Universities Mentoring Scheme (WUMS) a collaborative HEFCW and Welsh universities funded project that works to establish inter-university mentoring partnerships for women employees in HEIs in Wales.
- **Performance Management.** Performance is managed through regular appraisal meetings, review of individual research plans and the establishment of clear individual research strategies, including maximising grant income to support this.
- **Development.** The internal induction and probation programme integrates new members of staff and facilitates their continued development. Induction meetings signpost sources of support and development within the School and wider University. Cardiff University offers a wide range of workshops and courses that fulfil training needs.

Equality and Diversity. All staff involved in recruitment and retention undertake formal Equality and Diversity training. All promotion decisions are based upon excellence and are made according to a formal Scheme of Assessment which applies equally to all staff, taking into account their contractual arrangements and all relevant equality and diversity issues. Effectiveness of commitment to equality and diversity is evidenced by the Athena SWAN Bronze Award to the School of Biosciences (in 2013) in recognition of success in recruiting, retaining and promoting women in Science, Engineering and Technology. The University was ranked 49th in 2012 in the Stonewall Top 100 Employers in Britain for lesbian, gay and bisexual people and Cardiff is now one of only two UK universities to achieve top marks from Stonewall for support to prospective students.

ii Research students

The School of Biosciences has a vibrant culture for postgraduate education with students drawn from a wide variety of backgrounds and funding sources and striving to be the location of choice for the best graduate students. Currently there are **192 research students** (PhD, MPhil, MD, MRes) in the School, funded by major funding bodies including BBSRC, MRC, NERC, CRUK, ARUK and KESS. The number graduating each year with the degree of PhD has increased during the REF period from 23 in 2008/9 to 36 (+21 MRes students) in 2012/13. In the REF period, the following RCUK studentships (including industrial CASE studentships) were obtained: 28 BBSRC; 3 EPSRC; 1 ESRC; 14 MRC; 8 MRC (Capacity Building); 7 NERC. The School has been successful in increasing its iCASE and Industry-funded studentships at both PhD and MRes levels. Biosciences at Cardiff is also benefitting from the Sêr Cymru income stream with successful funding for three new studentships for January 2014 in the first tranche. In total Sêr Cymru is projected to fund a total of 100 studentships over the 2014-2017 period. Commitment to recruit overseas postgraduate students is evidenced by the newly implemented “buddying” system whereby high quality overseas candidates are personally helped through the application process (including visa and funding applications) by a member of staff.

Specific PhD programmes include:

- The **Wellcome Trust funded 4 year PhD Programme in Integrated Neuroscience** is led by the School’s Neuroscience section (Vincenzo Crunelli) and works in collaboration with the Schools of Psychology and the Institute of Psychological Medicine. The original Wellcome Trust

Award of £5 Million for 6 annual intakes of 5 students - 30 students in total - was extended for a further two years (10 additional students) in September 2012.

- **Cancer Research UK studentships**: Clinical PhD Fellowships – two students were recruited for 2010/11 (studentship includes tuition fees, clinical salary and research expenses) and two more - one fully CR-UK funded and one part funded by them (£75K) and part funded by Stepping Stones (£150K) for 2013/2014. Non-clinical PhD Fellowships – four students were recruited, one in each academic year from 2010/11 to 2013/14.
- The School has a strong current and past record in the field of **CASE** studentships and also has a number of fully funded industrial research studentships. In the REF period the School was awarded: 8 BBSRC Industrial CASE studentships and 7 BBSRC Quota case partnerships. Industrial collaborations include Q-Chip, Eli Lilly, Astrazeneca, Lumora Ltd, Merck Serono, Oxitec. Five NERC Industrial CASE awards with industrial partners CEH, Zoological Society of London, British Trust of Ornithology and SCRI.
- The **Knowledge Economy Skills Scholarships (KESS)** project is a collaboration between nine Welsh Universities and funded under the European Social Fund (ESF) Convergence Programme by the Welsh European Funding Office (WEFO). In the REF period eight PhD students were recruited to the School through KESS.
- The School's aim to further build its postgraduate research community is also supported by internal initiatives such as: **Cardiff University President's Research Scholarships Scheme** funding ten new PhD students since its inception in 2010 and a School PhD Studentship scheme which supported nine new PhD students in 2012/13.
- There are five PhD studentships attached to **Prof Yves Barde's Sêr Cymru Research Chair Programme.**
- **Cardiff/Bristol Doctoral Training Partnership** – As part of the increasingly close collaboration with Bristol University, the forthcoming BBSRC Doctoral Training Partnership bid with Bristol University will, if successful, result in an additional 3-4 studentships per annum.
- A bid was also submitted as part of the **GW4 + NERC Doctoral Training Partnership (DTP) Competition**.

Mechanisms to support Postgraduate Research. The School employs a Postgraduate Research leader, a dedicated Postgraduate and Research Office [6 FTE administrative staff] and the Postgraduate Research Board with membership drawn from across the School. The Board organises induction, skills courses, monitoring and mentoring and aims to provide the best working environment to encourage excellence in research by representation to the School's Research Committee. Research students represent their research community on the Postgraduate Research Board. The School has employed a dedicated HEFCW-funded Employability Advisor, providing specialist support and advice to students, including work placements to improve their employability. The School's Innovation & Partnership Officer also has a key role liaising and networking with employers to arrange work placement activities that benefit all parties.

All postgraduate research students and their supervisors are members of the **University Graduate College**. Cardiff University also provides a **Graduate Centre** which is recognised (by UKGRAD) as a hub for the postgraduate community and a provider of highly valued social and study facilities. PhD students are required to attend all Plenary Lectures by international cutting-edge scientists and appropriate seminar programmes. The annual Speaking of Science student-led conference gives participants the opportunity to present their research to a non-specialist audience in a supportive environment.

Recruitment Procedure. A robust recruitment procedure is in place whereby each potential applicant is interviewed by the prospective supervisory team along with at least one divisional Postgraduate Tutor.

Progress Monitoring Procedure As part of the University's Research Student Progress Monitoring Procedure, students and their supervisors are required to produce formal progress reports at 6-monthly intervals. These reports are assessed by an Independent Assessor, following discussion between the student and their Thesis Committee (1st Supervisor, 2nd Supervisor and Independent Assessor). Yearly progression is recommended by the Independent Assessor based

upon quality of the progression report and viva voce examination (Year 1: Review of the state-of-the art; Year 2; Research manuscript (4 year students) or mini thesis (3 year students); Year 3: mini thesis (4 year students). Ultimately, yearly progression is decided upon by the Post Graduate Board. Thus, the progress of every research student is formally reviewed, in accordance with the procedures set out in the School and University Frameworks, on an annual basis up until the completion of the research study. The School provides regular opportunities for its research students to communicate individual and collective feedback, which is reviewed and addressed at the Postgraduate Research Board; at least one student representative is part of this Board. A Postgraduate Research Experience Survey is conducted on a biennial basis.

d. Income, infrastructure and facilities

i.Research Income

New external grant awards totalled £12.6M in 2011/2012 and £14.7M in 2012/13, exceeding targets set by the University. It is the School's policy to allocate a major part of the overhead income to individual PIs to further support their research. Recently, an increasing proportion of this income has, with encouragement from the School's leadership, been used to generate support for PhD students.

Examples of significant grant awards in the period:

- **Borri** obtained a 5-year EPSRC Leadership Fellow Award (£1.1M) in 2010 to develop novel multi-photon microscopy technologies.
- **Clarke** obtained a 5-year CR-UK Programme Grant (Assessing the therapeutic potential of MBD target proteins in colorectal cancer - £1.8M).
- **Crunelli's** 5-year Wellcome Trust Programme Grant (Mechanism of physiological thalamocortical rhythms - £1.4M) was renewed in 2010.
- **Crunelli** and **Harwood** received £1.7M as a component of a Wellcome Trust Strategic Award.
- **Dale** has together with **Harwood** and **Borri** established the company Nanotether Discovery Science Ltd and raised £2.25M from private industry to support 7 members of staff.
- **Davies** led a €3.4M international consortium funded by the European Commission to uncover molecular mechanisms underlying dopaminergic neuron generation, survival and growth, involving partners in Stockholm, Munich, London and Helsinki and his 5-year Wellcome Trust Programme Grant (The TNF superfamily in neuronal development - £1.4M) was renewed in 2008.
- **Fox's** 5-year MRC Programme Grant (Molecular and structural determinants of plasticity in the cerebral cortex - £1.2M) was renewed in 2009.
- A team including **Durance, Ormerod** and **Bruford** led the UK's largest successful bid to the NERC Biodiversity and Ecosystem Service Stability thematic program which commenced in 2012 (School of Biosciences component: £1.2M).
- **Murray** and **Dewitte** led a £2.5M international consortium in Systems Biology (ERA-NET) on multi-scale modelling of shoot growth in the plant Arabidopsis involving partners in Lyon, Montpellier and Helsinki.
- **Petersen's** 5-year MRC Programme Grant (Calcium signalling, organelle dysfunction and pancreatitis) and the associated MRC Professorship (total: £2.3M) were renewed in 2012.
- **Rosser** and **Dunnett** obtained a 4-year FP7 funded grant (Human pluripotent stem cell differentiation, safety and preparation for therapeutic transplantation in Huntington's Disease - £1.4M).
- **Smalley** was awarded a £900K CRUK Programme Grant (Stem and progenitor cells and the origins of breast cancer heterogeneity).

ii.Infrastructure and Facilities

In August 2013 the ECSCRI moved into the Hadyn Ellis Building, which is the first building on the Maindy Park Site, a phased development of buildings for research and postgraduate teaching. The £30M Building (only a few minutes walk away from the School's main [Sir Martin Evans] Building), with investment in new state-of-the-art equipment (for example, eight tissue culture rooms and ten microscope rooms) exceeding £2M, will also house the NMHRI, see Overview and Research Strategy Sections).

A new (2012) £4M extension of the Sir Martin Evans Building Complex provides new state-of-the-art meeting facilities, cafeteria for staff and students and offices. This development facilitates formal and informal interactions between the four sections as well as between individual staff members and research students. There has also been extensive refurbishment of laboratory space (including the construction of controlled environment laboratories for researchers employing insect models in genetic research, the construction of controlled environment containment, emulating terrestrial and aquatic environments for biodiversity research, the construction of high quality dual photon microscopy laboratories accessible to a range of researchers, the construction of constant environment laboratories for genetics research employing a range of plant species and the development of greenhouse facilities to house genetically manipulated plant species) at a cost of ~£3M and investment in new state-of-the-art equipment (for example, Two-Photon System) exceeding £1M.

The **Research Infrastructure Fund** (RIF) supports equipment replacement at a proposed minimum threshold of £200K. Recently, two awards have been made to Biosciences to support, respectively, improved bioinformatics infrastructure and the purchase of a Transmission Electron Microscope.

Experimental MRI Centre. The School has created a support facility for researchers both within and external to the school, known as **EMRIC (Experimental MRI Centre)**. This unit is directly supported by a component of the recent Wellcome Trust Strategic Award (£5.1M). The facility serves research groups within Cardiff University as a whole, and acts as a national resource for high resolution research imaging.

In the REF period the School has established two successful collaborative research and training facilities in Malaysia, **The Danau Girang Field Centre** and the **Sugud Islands Marine Conservation Centre** (see *Research Strategy* section).

All of the structures we have created are overseen by appropriate boards. For example the CRUK Cardiff benefits from both an executive board and a governance board, the latter of which comprises representatives from the funders, the university, the NHS and the Welsh Government.

e. Collaboration or contribution to the discipline or research base

National, cross-HEI and international collaborations

The **Climate Change Consortium of Wales (C3W).** This is a cross HEI collaboration with the universities of Aberystwyth, Bangor and Swansea financed (£4M) by the Welsh Government through the Higher Education Funding Council for Wales (HEFCW). C3W has two overarching aims: to improve understanding of the causes, nature, and timing of climate change and its consequences for the environment and humanity; and to develop climate research in Wales as an international centre for climate change research. Six partner schools at Cardiff are involved (Biosciences, Psychology, Earth and Ocean Sciences, Planning and Geography, Engineering and Social Sciences), testifying to the interdisciplinary nature of the research.

New opportunities for collaborations with colleagues in Bristol, Bath and Exeter will occur following the recent establishment of the **Great Western Four (GW4)** group of universities.

Further examples of national and international research organisations, which we collaborate with, include: **Dow Agrochemical; Embrapa, the Brazilian Agriculture Research Corporation; Environment Agency, Abu Dhabi; the Honduran government; Chinese Academy of Science; Proctor and Gamble; Northeastern Gas Association of US (NYSEARCH); Unilever; Wellcome Trust Sanger Institute; Novartis Vaccines Institute for Global Health, Siena; Forestry Commission; Welsh Water; Sanofi, Frankfurt; RIKEN Brain Science Institute, Japan Science & Technology Agency and GlaxoSmithKline, Stevenage.**

Participation in peer-review process. National and International grants committees. Service on important editorial boards, committees of significant funding bodies and influential scientific societies is also encouraged. *Examples* of such activities include:

- **European Research Council (ERC):** Ole Petersen was Chair of Starting Grant Panel LS4 (Physiology, Pathophysiology and Endocrinology) in the funding rounds 2009, 2010 and 2011. He is a member of the new Consolidator Grant Panel for Physiology, Pathophysiology and Endocrinology in the 2013 funding round.
- **The Royal Society:** Ole Petersen was a member of the Royal Society/Wolfson Research Merit Awards Committee (2008–2011)
- **Biotechnology and Biological Sciences Research Council (BBSRC):** Helen White-Cooper has been appointed a core member of BBSRC Grant Panel C (2014-2017)
- **Medical Research Council (MRC):** Alan Clarke was Deputy Chair of the Molecular and Cellular Medicine Board until April 2012. Alan Clarke is a member of the Regenerative Medicine Programme Committee 2013 onwards. Kevin Fox was Deputy Chair of the Neuroscience and Mental Health Board until April 2012.
- **Natural and Environmental Research Council (NERC):** Lynne Boddy is Chair of the Peer Review College (2007-)
- **Cancer Research UK (CR-UK):** Alan Clarke was Deputy Chair of the Fellowship Board until 2013.
- **Swedish National Cancer Panel:** Alan Clarke is a member of this panel (2010-)
- **Academy of Finland**: Mike Bruford was a member of the Academy of Finland: Ecology and Evolution Fellowships panel (2008–2012)

Editors of scientific journals (selection):

- **Physiological Reviews:** Ole Petersen was Chair of the European Editorial Committee (European Executive Editor) (2003–2011)
- **Current Biology:** Ole Petersen (2002-) and Frank Sengpiel (2006 -) are members of the editorial board.
- **Physiology:** Ole Petersen is a member of the editorial board (2010-)
- **Carcinogenesis:** Alan Clarke is Executive Editor (2005-)
- **Pflügers Archiv – European Journal of Physiology**: Ole Petersen is Executive Editor (1992-); Oleg Gerasimenko is member of the editorial board (2007-)
- **FEMS Microbiology Ecology**: Andrew Weightman is a member of the editorial board (1998-)
- **Brain Research Bulletin**: Stephen Dunnett was Editor-in-Chief (1994-2009)
- **Fungal Ecology**: Lynne Boddy is Editor-in-Chief (2008-)

Fellowships (Memberships) of major national and international academies and awards:

- **The Royal Society:** Alun Davies FRS, Nobel Laureate Robert Huber For Mem RS, Ole Petersen FRS (Ole Petersen is the Royal Society's representative on **EASAC's** (European Academies Science Advisory Council) **Biosciences Steering Panel**).
- **German National Academy of Sciences Leopoldina**: Robert Huber ML, Ole Petersen ML
- **Academia Europaea**: Vincenzo Crunelli MAE, Alun Davies MAE, Kevin Fox MAE, Robert Huber MAE, Ole Petersen MAE (Ole Petersen is a Member of the Executive Board, Chair of the Nominations Committee and Member of the Organizing Committee for the Academy's 25th Anniversary Meeting in Wroclaw, Poland, September 2013)
- **Learned Society of Wales:** Lynne Boddy, Paola Borri, Michael Bruford, Alan Clarke, Alun Davies, Stephen Dunnett, John Harwood, Jim Murray, Steve Ormerod, Ole Petersen (Member of Council and Finance Committee), Anne Rosser, Andrew Weightman.

Other notable awards:

- Ole Petersen was awarded the 2013 **Horace W Davenport** Distinguished Lectureship by the **American Physiological Society** and gave the Award Lecture at **EB2013** in Boston.
- Jim Murray was named as **BBSRC Commercial Innovator of the Year 2012** for development of a new detection system for DNA amplification.
- Michael Bruford and Jim Murray received **Royal Society/Wolfson Research Merit Awards** in 2011 and 2012 respectively