Institution: Swansea University
Unit of Assessment: 3a - Allied Health Professions, Dentistry, Nursing and Pharmacy
a. Context

The main beneficiaries of research conducted by the College of Medicine are:
(1) Patients across the world through their healthcare systems, especially the NHS and its staff.
(2) Populations via governments, notably Welsh Government and National Institute for Social Care & Health Research (**NISCHR**), Welsh equivalent of National Institute for Health Research (**NIHR**).
(3) The healthcare industry, mainly enterprises in biotechnology, electronics or pharmaceuticals.

(1) Patients and healthcare: College provides rigorous evidence needed to provide patients with care that is effective, efficient, equitable, safe and timely; and thus achieves impact by improving the health and well-being of patients and their carers. The original 11 clinical research teams focus on arthritis, cancer, children, diabetes, digestive diseases, epilepsy, emergency care, haemostasis, injury, mental health, and older people. To coordinate these teams, College created the (research) **Institute of Life Science (ILS)**, now host to: (A) the Centre for Improving Population Health through E-Health Research (**CIPHER**), recently funded by an MRC-led consortium to investigate the main chronic conditions that burden the population of the developed world, including cancer, cardiovascular disease and diabetes; (B) the Centre for Administrative Data Research & Evaluation (**CADRE**) Wales, funded by ESRC to strengthen UK's competitive advantage in 'big data'; (C) the Swansea arm of the BEACON initiative, funded by the Welsh European Funding Office to develop the technique of 'bio-refining' to identify and produce pharmaceuticals; and (D) nine all-Wales clinical research networks funded by NISCHR – studying arthritis, cancer, children's health, diabetes, epilepsy, emergency & unscheduled care, gastroenterology, mental health, and older people. To underpin these groupings, the College has created impact-focused links to the NHS, especially Abertawe Bro Morgannwg (i.e. Swansea & West Glamorgan) University Health Board (**ABM UHB**) and Hywel Dda Health Board, covering the rest of South West Wales. The link to ABM UHB is a formal partnership in clinical care, teaching and research, whose success owes much to a joint management structure including Partnership Board, Scientific Review Committee, and Joint Clinical Research Facility including Clinical Imaging Unit and Clinical Trials Unit (**CTU**).

(2) Populations and governments: To provide methodological support to the nine listed networks, ILS also hosts 3 research infrastructure groups funded by NISCHR – Heath Informatics Research Unit (**HIRU**), Welsh Health Economics Support Service and CTU. Responsibilities of CIPHER, research networks and support groups include: (i) focusing on key translational gaps; (ii) conducting rigorous pragmatic evaluations of innovations in healthcare through randomised trials and secure anonymised information linkage; (iii) training and engaging service users in the design, conduct, management and reporting of these studies, in collaboration with Involving People, the section of NISCHR responsible for public engagement; and (iv) achieving research impacts, notably through the pathway from translation through evaluation to evidence developed and disseminated – via traditional publication, the Welsh Government, the National Institute of Health & Care Excellence (NICE) and the Cochrane Collaboration internationally.

(3) Healthcare industry: ILS has engaged industry by providing companies with modern accommodation and support – biomedical, clinical, electronic, engineering, technical and commercial – thus achieving economic impact in: (a) individual enterprises; (b) the 'convergence region' supported by the Wales European Funding Office including 11 Local Authorities in South and West Wales; and (c) the UK and beyond. Support from College has come from the original 11 clinical research teams and the original nine biomedical research teams – in bioinformatics, cell biology of cancer and reproduction, immunity and allergy, mass spectrometry, medical physics and clinical engineering, microbiology and infection, nanomedicine and medical devices, molecular neurosciences and physiological sciences. To link all these teams with their natural beneficiaries in the healthcare industries, and thus underpin its strategy for research and impact, ILS houses and supports these enterprises alongside the College's own research staff of some 80 academics and 95 researchers, together with 140 research students.

b. Approach to impact

The Institute of Life Science occupies two modern research buildings worth more than £100 million including equipment. It is located between the University and Singleton Hospital, one of two major

hospitals in Swansea. It is the fruit of partnership between: the Welsh Government, for whom it is the largest investment on any university campus; Swansea University; NHS Wales, mainly through ABM UHB; IBM; and Siemens. It is the embodiment of the College's research and impact strategy with the shared vision: "*to benefit human health by advancing medical* ***and allied health*** *sciences through inter-disciplinary research and innovation, and to link those benefits to the economy by encouraging collaboration with a wide range of organisations in a spirit of open innovation*". Though the College began as a Clinical School, subsequent growth into biochemistry, genetics and information science has ensured that impacts, notably those reported in our REF case-studies, benefit patients and carers (i.e. 'users'), the general public and many health professions, notably doctors, nurses, paramedics and pharmacists, in the UK and beyond. To ensure these benefits accurately reflect users' needs, the CTU working with the nine all-Wales clinical research networks have developed, published and implemented a Standard Operating Procedure for including users in the development, management, reporting and dissemination of research; they are now assessing the extent to which including users to achieve equity also enhances impacts.

The first phase of ILS (**ILS1**) is a £52 million investment in medical research, partly funded by the Welsh Government, European Regional Development Fund, and Swansea University. It covers 5000m^2 and houses over 200 professional specialists in biomedical research, technology transfer and business incubation. The second phase of ILS (**ILS2**), completed in December 2011, occupies land leased from ABM UHB and cost £29m, of which £13m came from the European Regional Development Fund, £10m from the Welsh Government, and £5m from the University. ILS2 provides another 6000 m^2 for impact-focused activities including: the Centre for NanoHealth, a joint initiative with the University Colleges of Engineering and Science, separately funded for another £22m; a tripling of the space for business incubation; and Joint Clinical Research Facility including Clinical Imaging Unit and CTU. Distinctive facilities of ILS also include CIPHER and CADRE described in **Section a**, the EPSRC-funded National Mass Spectrometry Service Centre, the NHS Wales Research Informatics Laboratories, Blue C – an IBM-built supercomputer for life science research, and complementary access to High Performance Computing Wales.

This planned juxtaposition of: (A) the College of Medicine engaged in distinctive programmes of teaching, notably graduate-entry medicine; (B) modern research facilities in biomedical sciences, clinical sciences, health informatics and medical engineering; (C) College management structure that pursues the shared vision above by giving equal weight to scientific innovation, research and teaching; and (D) the supportive ILS innovation and business development team – has stimulated the development of a thriving life-science cluster within and around ILS and across South and West Wales. Companies successful in incubation include: (i) Boots Centre for Innovation, who have now graduated from their incubation phase in ILS; (ii) Calon Cardio-Technology Ltd, who have developed a minimally invasive blood pump for heart failure; (iii) CyDen Ltd, who have developed 'intense pulsed light', safe light therapy for health and beauty treatment; (iv) Haemair Ltd, who are developing an ambulatory artificial lung; and (v) Maimonidex (UK) Ltd, a pharmaceutical company developing drugs to treat auto-immune diseases like rheumatoid arthritis. This cluster also includes more than 30 affiliate members – enterprises who benefit from ILS expertise and facilities but not accommodation. In these ways the ILS has achieved five-year targets for economic growth, many ahead of schedule. The externally audited economic impact of ILS since 2007 includes: (a) creating 40 new companies and more than 400 jobs; (b) registering more than 30 new patents and trademarks; (c) providing research support to more than 200 enterprises, who won investment of £30m and increased total turnover by £15m; and (d) initiating more than 50 collaborative research projects between academia and industry.

As well as the programme grants for CIPHER and CADRE, HIRU won funding from Academic Enterprise for Business to develop the e-Health Innovation Industries (**eHI^2**) centre for this rapidly growing sector of the Welsh economy. eHI^2 works with 70 enterprises, from small to multi-national, to create innovative e-health products and services with global market potential by providing efficient access to their powerful health informatics research laboratories, expertise, and extensive academic and service network. By achieving its initial targets for economic growth, eHI^2 provides another successful example of the ILS collaborative model at work.

In short the College has both initiated a programme of traditional biomedical and healthcare research and translated it into sustainable economic activity through multidisciplinary open

innovation. This led EU Commissioner Danuta Hübner to describe ILS as "*an initiative exemplifying best practice in the burgeoning knowledge management sector*". The ILS innovation team has given advice on, and support for, similar strategies to governments in India, Malaysia, Saudi Arabia, South Korea, United Arab Emirates and USA.

c. Strategy and plans

The ILS impact-focused philosophy has proved adaptable to changing opportunities for achieving impact. For example activities in ILS1 are mainly biomedical, while those in ILS2 are more clinical. One measure of the success of this approach is that we are currently building the third phase of ILS to house HIRU, CIPHER, CADRE and eHI^2, thus freeing accommodation in ILS2 for both the growing College research community and for those waiting for business incubation space.

ILS continues to benefit from the strong University commitment to enterprise, which supports the College in three main ways: (1) the developing second campus – for Science and Innovation – will release space on the crowded site adjacent to Singleton Hospital, the natural site for the College of Medicine; (2) the University-owned Swansea Innovations Ltd facilitates commercial exploitation of knowledge, research and development emanating from ILS; and (3) the Human Resources Department has extended available career pathways – to encourage flexibility and enterprise.

We recently strengthened the College strategy for research and impact. We inaugurated the College External Advisory Group, especially to guide innovation and entrepreneurship. We appointed Prof Marc Clement as Director of Enterprise to lead the ILS innovation and business development team and the new Enterprise & Innovation Committee. This initiative will benefit from the growing Welsh Government commitment to life sciences, manifest in the creation of: (A) Health Research Wales – a seamless all-Wales sign-posting and facilitation service designed to promote Wales in the arena of international R&D; (B) a life science hub in South Wales, supported by the Arthurian Fund to engage potential partners across the UK, Europe and America; and (C) Sêr Cymru – a £7m National Research Network in Life Sciences and Health comprising the four Welsh research universities, which will focus on drug discovery and development.

To focus resources, we created four research themes – biomarkers & genes, (medical) devices, microbes & immunity, and patient & population health and informatics – each led by a senior, experienced researcher. Researchers will have a primary theme, and will contribute across themes. We have introduced this new level of management, between individual teams and ILS as a whole, to enhance collaboration in: (i) conducting research; (ii) translating that research from bench to bedside; (iii) engaging with government, industry, healthcare and patients; and thus (iv) extending the reach and significance of our impact. The tools for achieving these objectives will include regular structured meetings, training, and monitoring against College objectives and performance indicators in the way that we already monitor staff development.

Our updated strategy for impact commits the College Directors of Enterprise and Research to work with the 4 new research themes to plan future impact from all major research programmes, and the College Directors of Enterprise and Teaching to develop related postgraduate degrees, notably in Life Science Enterprise & Innovation, Medical Services Management and Pharmaceutical Management. The present College impact group refined our submission to REF 2014, identified potential case-studies for REF 2020, and began to engage all 3 identified constituencies – patients through the NHS, populations through governments, and healthcare industry – and plan & monitor the uptake of impact. To exploit the growing body of theory and practice in achieving and evidencing impact, we have strengthened this group by adding the Director of Enterprise and recruiting external members to cover the spectrum from research through production to marketing. To illustrate this process we conclude this section by exemplifying five of the portfolio of ***prospective*** impact case studies on which we plan to focus in the next quinquennium:

(a) Calon Cardio-Technology, based in ILS2, will continue to refine, market and commercialise their ventricular assist device (VAD) – a minimally invasive blood pump for heart failure designed to minimise blood damage. In collaboration with three of our four research themes they plan to monitor uptake and impact on quality of life and the prevalence of severe heart failure.

(b) The research arm of Diabetic Retinopathy Screening Service Wales, who recently moved to ILS, have plans to implement their recent research on screening intervals across Wales and monitor international uptake of their findings beyond 2020.

(c) The Haemostasis Biomedical Research Unit, funded by NISCHR from 2011, are testing biomarkers to characterise blood clots for product development through ILS, clinical trials with the CTU and translation into clinical practice, notably for cancer, heart attack, sepsis and stroke.

(d) The In Vitro Toxicology Group have developed methods for testing genotoxicity in nano-materials and shown the need to adapt current regulatory assays. They will continue to collaborate with policy-makers and monitor the impact of this research on regulatory policy.

(e) The emergency care research team have persuaded Welsh Government to delay rolling out the promising but untested predictive risk stratification model (**PRiSM**) for identifying patients at risk of emergency admission until the ILS-based NIHR-funded PRiSMATIC trial has evaluated the software in 32 practices across ABM UHB; the team plan to monitor uptake of PRiSM and analogous models across the UK beyond 2020, and thus the impact of current research.

d. Relationship to case studies

Several founding staff began the research leading to the five ***submitted*** case studies around the start of the Clinical School in 2004. The updated impact strategy described in **Section c** took account of these and other exemplars: (1) Prof Clement's clinical trial of lasers to treat acne, and his subsequent development and marketing of light therapy to treat skin disorders for therapeutic and cosmetic benefit, stimulated a market now worth billions in partnership with market leaders like Procter & Gamble, Unilever and Sony UK. This provided both a major stimulus to found the ILS and develop its philosophy, and an essentially commercial prototype for our strategy for impact.

(2) On joining the College, Prof John Williams continued to develop and evaluate new ways to manage patients with debilitating gastrointestinal disorders, focusing on open access to care for inflammatory bowel disease and on nurses undertaking endoscopies. By achieving impact through information technology and changing professional roles, he created an intrinsically public-sector route to impact.

(3) Williams also showed wide variations in quality of hospital records, and led the development of evidence-based standards for those records that received wide endorsement from professional and statutory bodies, culminating in the Department of Health. This represents another public-sector route to impact – one in which the basic approach was to change institutional and organisational norms through evidence-based lobbying.

(4) Prof Helen Snooks collaborated with NHS providers to develop and test models of pre-hospital emergency care that reduce transfer by ambulance to Emergency Departments. As leader of our third case study following a public-sector route to major impact on NHS procedures and costs, she integrated Williams's twin approaches by combining information technology with the dissemination of rigorous evidence, and changed both professional roles and institutional norms.

(5) Prof Gareth Jenkins showed that low-level exposures to genotoxic agents do not damage DNA. To change regulatory guidelines on assessing drugs, and reprieve some drugs with genotoxic activity, he combined evidence-based lobbying of the European Medicines Agency with a fruitful collaboration with a major pharmaceutical company.

Thus case studies 2, 3 & 4 all enhanced the ILS impact strategy by achieving effective liaison with the public sector in the form of governments, health care providers and professional bodies, both at home and abroad. Other case studies, notably 5, enhanced the ILS impact strategy by achieving effective liaison with both international organisations and multi-national companies. In future ILS will continue to develop both our impact strategy and our methods for developing, conducting, publishing, disseminating, implementing, and monitoring (impact from) rigorous scientific research to ensure that, as the fastest growing British medical school, we continue to achieve exceptional impact pro rata.