Institution: University of Birmingham

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

a. Context

Our research and development portfolio aims to deliver a strong translational impact on the oral and dental health of the population. Whilst oral and dental diseases are not in general life threatening, they do impact upon overall health and wellbeing and common disease pathways exist between oral and systemic diseases. Furthermore, tooth retention and treatment in our increasingly ageing population is a major healthcare challenge. **Thus, the main beneficiaries and end-users of our research are government policymakers, healthcare professions, industries and the patient population at large**. We recognise that all beneficiaries and end-users require robust evidence underpinning new treatment developments and therefore demonstrating our research impact to the academic community is of fundamental importance to all stakeholders.

All of the research programmes within our theme areas have demonstrable impact and the stage of translation for individual programmes varies according to their nature and end-users. Research in **dental public health and epidemiology** (*White, Hill*; 1998 & 2009 UK Adult Dental Health Surveys, 2002 & 2013 UK Child Dental health Surveys) is directly impacting on models for **national policy on healthcare provision and workforce planning in the UK** (NHS Personal Dental Services scheme). We have also extended the broad scope and impact of our research by investigating the relationship of oral health/disease with other common systemic diseases, such as rheumatoid arthritis, cardiovascular disease & diabetes (*Chapple, Dietrich*). Our pioneering early adoption of **Practice-based Research Network (PBRN)** approaches (now emulated in the US with >$40m NIH funding) have enabled mining of "real-life" datasets relating to the clinical evaluation of performance of dental restoratives within the general dental practice setting. Outcomes from this research have particularly impacted on clinicians and industry by identifying new and improved treatment approaches which overcome the limitations relating to both materials and operator application (*Burke, Stewardson*).

Basic exploratory research is developing new biomaterials (eg calcium phosphate and silicate cements, resin bonded composites, etc) (*Palin, Hofmann, Addison, Shelton*) as well as novel tissue restorative approaches for regeneration and engineering of tooth and bone tissues (*Smith, Shelton, Sammons, Cooper, Scheven, Lumley*). Analysis of host interactions with widely applied biomaterials, such as dental resins and titanium implants, is aimed at developing novel therapeutic approaches for patient benefit (*Palin, Shelton, Addison, Sammons*) by **translational research with industrial partners**.

Novel research on biomarkers using oral and systemic fluids and tissues have underpinned developments of new diagnostic and biofeedback approaches for wellness, risk assessment and preventive approaches in healthcare (Impact Case study - Predictive Technologies & *Landini* cancer diagnosis using quantitative histopathology imaging). These approaches have also enhanced our understanding of disease pathogenesis, which is fundamental to new future therapies. Further therapeutic and commercial impact derived from our research into **novel patient-based care products** is demonstrated by our extensive programmes of research on toothpastes and products for tooth wear prevention (*Smith, Cooper*), micronutrients (Impact Case study - Micronutrient Approaches) and novel ultrasonic cleaning regimes (*Walmsley*). Our pioneering analyses of large epidemiological datasets (*Dietrich, Chapple*) have informed key European clinical research directions for healthcare impact (EU Gums & Joints FP7 & RAPID FP7 ITN - highest scoring proposal in 2010), and are providing new insights into the impact of periodontal disease on rheumatoid arthritis, and subsequent future novel therapeutic strategies.

While all our research programmes demonstrate significant impact initially in academic user groups ultimately, they aim to benefit patients by translation into healthcare products through our **broad and robust industrial collaborations** (including Unilever, GSK, NSA, Philips, J&J, 3M-ESPE, Dentsply). We have attracted significant industrial research support (CASE studentships and post-doctoral researchers) and many of our staff are key members of industrial scientific advisory boards which help guide company direction, policy and product development.

b. Approach to impact

The **translational nature** and, consequently, impact of our research is embedded within the School's research theme structure. This begins with hypothesis generation from analysis of epidemiological datasets and basic mechanistic research, and goes through to proof-of-principle and phase-3 clinical trials resulting in novel product development and evaluation within primary care settings. Dentistry represents a mixed medical and surgical speciality within which traditionally, there has been a relatively conservative approach to change in treatment modalities. However, we recognise and embrace the need for innovation and novelty within dentistry to provide major impacts on **disease prevention, diagnosis and treatment**. Several of our research areas seek to identify exciting new ways to improve oral and dental healthcare and capitalise on new developments in related fields, such as molecular medicine, 'omics' technologies, biomaterials stem cell science and tissue engineering.

Due to the diverse nature of our end-users and beneficiaries, our research aims to achieve impact by utilising a variety of approaches. For those research areas targeting particularly novel developments, we have interacted closely with the relevant academic communities where building a **strong evidence-base** is fundamental to scientific uptake. Traditional approaches of **research dissemination** are via relevant scientific meetings and conferences both nationally and internationally as well as through high-quality peer-reviewed scientific journals. We also target publication in journals which have the widest most relevant readership and that facilitate information reaching those most likely to use it (eg scientists/dentists).

We also **directly disseminate our research to dental clinicians** through appropriate meetings and in-house CPD courses, relevant professional journals and PBRNs to highlight future directions in dentistry. Notably, this user group frequently accesses information from different sources compared with academic audiences. Teaching on our **research-led undergraduate dental curriculum** also enables future dental clinicians to become early adopters of our research findings. Some of our research with direct impact on healthcare requires interaction with **policymakers** through specialist organisations such as the **Department of Health** and **British Dental Association** (*Walmsley* - BDA Scientific Advisor). We have also pursued the impact of our research on a thriving, knowledge-based economy within our region through Birmingham Science City (*Palin*) which aims to partner the public, private and HE sectors in utilising science and technology to stimulate innovation to improve economic prosperity and quality of life.

Active public engagement and education to disseminate our research findings utilises press interactions (eg, TV, radio and newspapers supported by our institutional press office), publication of a School Blog, showcasing our research at the Birmingham ThinkTank Science Museum, speaking at Cafe Scientifique events (*Walmsley)*, participating in science festivals (*Grant, Cooper, Smith*), which all provide a direct line of communication to the public.

Our approaches to impact are underpinned by **early engagement with end-users** including **patient and public involvement (PPI)** forums and consultations with our industry collaborators. PPI forums enable appropriate research planning and targeting to ensure the development of treatments and products which meet their specific needs. Our industrial collaborative relationships facilitate commercialisation and this is complemented with the University's commercial expertise which has enabled us already to generate spin-out companies, such as for online risk assessment [Oral Health Innovations (OHI) Ltd] and near patient testing using saliva (GFC Diagnostics Ltd).

Support for staff on impact generation and activities are provided by the College's **Research & Knowledge Transfer (R&KT) Office**. Business Engagement (BE) Managers advise staff and facilitate BE activity and Public Engagement (PE) champions advise staff in PE and in identifying funding to support PE activity. Staff also routinely engage in enterprise & entrepreneurship training and IP/commercialisation workshops to support impact creation via this Office.

c. Strategy and plans

Our strategy to support and enable future impact is embedded in our School's research programmes, which are themed around a limited number of focussed areas where we have strong expertise and international reputation. Our overall goals are to ultimately **maximise impact** as broadly as possible from our research for **all stakeholder groups,** including the scientific, clinical, industrial and patient communities.

Development of New Research Areas: Under the guidance of the Strategic Research Committees (SRCs) of the School and College along with the School's Director of Research, Management Team and Research Administrator we aim to develop new research areas and collaborations with **broad and high impact**. New partnerships are developing between our Periodontal Research Group and several important systemic inflammatory disease areas, while our tooth and bone regeneration research is resulting in new collaborations within the Birmingham University Stem Cell Centre. We are also developing innovative research directions through our recent recruitment with *Cancer Sciences* of an expert cancer epigenetic scientist (*Wiench*) from the NIH, US. *Wiench* will develop an oral cancer research programme as well as adding impact to our current research areas in oral inflammation and tissue regeneration.

Support and Development of our Staff: While impact is firmly embedded within our current practice, we recognise that to continue to achieve this we must **monitor and train our staff to optimise** the **reach and significance** of their research. The College's **R&KT Office** provide supportive expertise, as described in section **b,** to ensure staff are aware of current and future national and international priorities and initiatives. Proposed new project areas by PIs are evaluated 12 weeks prior to grant submission, via 'Intention to Submit' forms, by senior School and College research leaders. A **climate of citizenship** is fostered to provide support and mentoring for junior staff from senior academics and research leaders. Junior researchers are also directed to University support mechanisms both prior to application and subsequently to enable optimisation of impact and dissemination of findings. Review of individual researcher's implementation of this is monitored and supported via the University's annual Performance Development Review.

Research Dissemination via Traditional Routes: Presentations are targeted at relevant scientific meetings and conferences, nationally and internationally, as well as publishing in peer-reviewed scientific journal articles. Open access publication is favoured and UoB provides financial support. Publications are also targeted to journals that facilitate information reaching those most likely to use it (researchers, clinicians or policy makers). As evidenced by our research outputs.

Early engagement with end-users: From an early project development stage researchers are encouraged to utilise our long-standing collaborative relationships with our **PPIs** and **PBRNs** appropriately to maximise pathways to impact. This approach ensures research is directly relevant to patients and clinicians and encourages use of lay language for dissemination.

Dissemination to clinicians and policymakers: Our direct engagement in dialogue with these groups via presentations at clinical meetings, policy workshops, Government committees, etc enables rapid uptake of research findings. As evidenced by section **e** of Environmental Template.

d. Relationship to case studies

The three **Impact Case Studies (ICSs)** submitted reflect the use of our wide range of approaches and strategies for generation of impact as described above. Indeed, different approaches were rigorously pursued to ensure impact was achieved in relation to the specific needs of the research. While ultimately patients are our intended end-users, different pathways to realising this impact have been utilised and, consequently, direct impact on clinicians, industry, the economy and local and national government policy has been achieved.

The **Dental Survey ICS** demonstrates our longstanding research involvement and expertise in the area of dental public health and epidemiology. This Case study in particular highlights the importance of our dialogue with policy makers, patients and the public. In contrast, the **Micronutrient Approaches and Predictive Technologies ICSs** highlight our robust and longstanding collaborations with industry and the importance of dialogue with the commercial sector from the outset in planning and realising future impact. These ICSs also highlight our involvement throughout the R&D pipeline, as well as demonstrating our commercialisation strategies for our generation of spin-out companies from the work.

While the dissemination of the work involved has used standard approaches of publication in scientific journals, the ICSs particularly highlight the need to publish both in journals read by dental clinicians and policy makers as well as those with higher scientific impact which support the academic rigour of the work. The ICSs also demonstrate our strategies of fostering collaborative and interdisciplinary research to optimise impact generation.