



## ORAL MICROBIOLOGY RESEARCH IN VICTORIA

Victorians have made great contributions to the understanding of oral microbiology and of how the micro-organisms that we carry in our mouths affect not only our oral health but also the health of our entire body. Over many decades, these studies have led to the translation of basic research into knowledge, policy, products and teaching that are improving the health of all Australians.

While it may seem an odd leap from kangaroos to humans, the origins of the study of oral microbiology at the University of Melbourne can be traced approximately to the mid-1970s and a publication in the *Journal of Dental Research* entitled ‘A microbiological study of normal flora of macropod dental plaque’ by David Beighton and William Miller from the departments of Conservative Dentistry and of Dental Medicine and Surgery in the Faculty of Dentistry. Other oral microbiology pioneers included Wallace ‘Wal’ McDougall, who was qualified with degrees in both dentistry and science, and Ian Johnson, who in 1983, with the support of Rexona Pty Ltd, published a Dental Plaque Monograph series, a comprehensive review of the current state of knowledge of the bacterial composition of dental plaque. Ian went on to obtain his PhD on oral microbiology in the Department of Conservative Dentistry.

During this time, much of the research in the field of oral microbiology was funded by the then Milk Board of Victoria, marking the start of a long and productive relationship between various dairy bodies and companies (such as the Victorian Dairy Industry Authority, and Dairy Australia), and the Melbourne Dental School (then the Faculty of Dental Science). Of great significance to the future success of research at the school were industry-funded research programs led by the recently graduated biochemist Eric Reynolds, who joined the school in 1980. He and Stuart Dashper (who joined the school as a research assistant in 1984 and is now professor in oral microbiology) worked on characterisation of the bacterial causative agents of dental caries, mainly *Streptococcus mutans* and *Streptococcus sobrinus*, and how to repair the damage that these organisms can inflict on the dentition. This research eventuated in the development of commercially available products based on components of milk that improve oral health, and went on to win Eric numerous awards, including the 2017 Prime Minister’s Prize for Innovation—an outstanding achievement in research in any field.

Cat. 76 **Model of oral bacteria in petri dishes, before and after cleaning teeth**, c. 1905, wood, glass, metal, resin, paper; 37.5 × 37.5 × 3.5 cm. HFADM 1488, Henry Forman Atkinson Dental Museum, University of Melbourne.

An increasingly diverse and growing research team, bolstered by NHMRC support, extended these early bacteriological studies, to investigate the causative agents of periodontitis and to characterise the features that enable these common oral bacteria to cause such a destructive chronic disease. This research was developed into a fruitful collaboration with CSL, and a world-first, million-dollar sequencing of the genome of the oral pathogen *Porphyromonas gingivalis* at the start of this century.

These two major programs of research formed the basis for the establishment and development of the Cooperative Research Centre (CRC) for Oral Health Science, and the Oral Health CRC (2003–18), a federally funded centre that translated basic research into oral health treatments. The CRC employed a multidisciplinary staff with backgrounds in microbiology, biochemistry, immunology, protein chemistry and molecular biology—among other fields—and grew to encompass many researchers, making up between one-third and one-half of all staff in the Melbourne Dental School during that time. More than 105 postgraduate students, including at least 29 PhD students, working in and around the field of oral microbiology were supported by the CRC, many of whom have moved on to share and build on their knowledge nationally and internationally. As an example, in 2018 three former PhD students from the school were part of the interdisciplinary team that established the Malaysian Society of Oral Microbiologists and Oral Immunologists.

Continuing close collaborations with clinical researchers in the school, including Ivan Darby who arrived in 2002, and the recruiting of talented PhD students led to a better understanding of the synergistic interactions between bacterial species involved in the progression of periodontitis, and to research programs aimed at understanding the polymicrobial biofilm nature of chronic oral diseases. The school's retention of clinically qualified younger researchers has enabled the teaching of oral microbiology and evidence-based preventive and therapeutic regimes to reach global best practice.

The development of a therapeutic vaccine for periodontitis was one of the major achievements of the Oral Health CRC; trials of this vaccine are continuing in the Centre for Oral Health Research, launched in 2019. The vaccine project was based on basic research into surface proteins' function, structure and secretion, and this has continued with the discovery and characterisation of novel bacterial secretion systems. The original projects, designed to discover antimicrobial peptides contained in milk, have developed over the decades into a highly collaborative and ground-breaking program of antimicrobial drug discovery, led by Neil O'Brien-Simpson, which has expanded its scope well beyond the oral

cavity. Changing theories on causation of oral disease, combined with rapidly evolving technologies, show the importance of studying the whole oral microbiome—the collection of all the bacteria, fungi, archaea and viruses in the mouth. These techniques are now being applied in the CRC to study a broad range of oral and systemic diseases, as well as the effects of dental treatments. Links between systemic diseases and the oral microbiome have been elucidated, leading to contributions to novel research on rheumatoid arthritis, Alzheimer's disease, diabetes and cardiovascular disease.

The original collaborations between the departments of Conservative Dentistry (now Oral Biology) and Dental Medicine and Surgery (now Oral Anatomy, Medicine and Surgery) have been continued with the discovery of the roles of viruses, fungi and bacteria in oral cancer. This is resulting in breakthrough research on causes of cancer and the development of predictive biomarkers.

A characteristic of the rich and varied body of research on oral microbiology at the University of Melbourne is the unwavering focus on preventing oral disease. The unravelling of the molecular mechanisms behind the ways in which oral micro-organisms cause the two most common oral diseases (dental caries and periodontal disease), and the search for ways to decrease their numbers in dental plaque and mitigate their damage to humans—both in the oral cavity and beyond—continues with a new generation of researchers, supported by ever-advancing technology.

**Dr Samantha Byrne, Professor Michael McCullough and Professor Stuart Dashper**