EDITORIAL

J.L. Ferracane[1]* and W.V. Giannobile[2,3]

[1]Department of Restorative Dentistry, Oregon Health and Science University, Portland, OR, USA; [2]Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI, USA; and [3]Department of Biomedical Engineering, College of Engineering, University of Michigan, Ann Arbor, MI, USA; *corresponding author, ferracan@ohsu.edu

# Novel Biomaterials and Technologies for the Dental, Oral, and Craniofacial Structures

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The ideal material for restoring or replacing lost oral tissues—whether bone, tooth, or soft tissue—may be elusive, but efforts to develop new and improved options continue at a rapid pace. The literature is abundant with citations describing new approaches to the production of biocompatible and structurally sufficient materials that can be applied to replace or repair dental, oral, and craniofacial tissues, targeting clinical efficiency and effectiveness. The trend for many years has been to develop materials that would not injure local or generalized tissues. While restoring form and function, these approaches were more in the line of inactive "space fillers" that do not significantly influence the biology of the oral environment (Fernandez-Yague *et al.*, 2014; Lai *et al.*, 2014). The use of dental amalgams and resin composites for direct restorations—as well as materials for indirect restorations composed of metals based on alloys of gold or other corrosion-resistant metals, porcelain, and other ceramics—has been widespread. The use of biocompatible materials, such as titanium and its alloys, has been used as implants for single- and multiple-tooth restoration and osseous anchorage for fixation devices. Inert polymers or biodegradable materials have been used as membranes for enhancing periodontal healing or sealing materials for endodontic apices. Dentistry has progressed tremendously because of the judicious use of these materials, especially to enhance the aesthetic outcomes for millions of patients.

However, examples of materials in regenerative medicine that are stimulatory of biomimetic processes are of great interest while still having difficulties of predictability in the clinical arena. For many years, calcium hydroxide has been used by clinicians for restorations in close proximity to the pulp. Experience with this lining material has provided guidance to usher in a new era of oral biomaterials development where the goal is to produce materials that are bioactive instead of simply biocompatible. Such materials operate on a very local scale, enhancing the replacement of hard tissue lost to disease. But the need for materials that can re-create tissues on a macroscale is great. These materials, designed to bioengineer lost tissue, require specific design elements. These include a biocompatible matrix material that provides structure for new tissue to grow within, in a well-defined spatial orientation; these also include bioactive molecules as an additive or *via* targeted cellular recruitment from the site that can promote regeneration in a temporal manner to produce the new living tissue. These new materials may contain additives on the nanoscale that deliver some of these essential components or additional molecules and ions that have an antimicrobial, tissue-anabolic, or remineralizing potential.

This special issue of the *Journal of Dental Research* contains a collection of timely articles designed to provide a review of some of these important new material developments, as well as examples of novel, state-of-the-art research work in these critical areas. Thematically, this issue covers several areas in materials development. It presents novel materials designed to replace or bioengineer lost oral tissues but with enhanced properties and performance expectations compared with current dental restorative materials (Ivanovski *et al.*, 2014; Kim *et al.*, 2014; Tatara *et al.*, 2014; Tevlin *et al.*, 2014). These include materials designed to be more resistant to mechanical failure and chemical/enzymatic degradation from bacterial biofilms (Feitosa *et al.*, 2014; Kitagawa *et al.*, 2014). The issue addresses important new advances in ceramic and composite materials for CAD-CAM applications (Kitagawa *et al.*, 2014; Ruse and Sadoun, 2014) and new adhesives and cements with enhanced properties and resistance to degradation at the tooth-restoration interface (Bacchi *et al.*, 2014; Dailing *et al.*, 2014; Osorio *et al.*, 2014). It further highlights new pursuits for engineering materials that can regenerate lost periodontal tissues through the precise delivery of bioactive molecules or pluripotent cells in a spatiotemporal scheme (Arany *et al.*, 2014). Similarly, the regeneration of dental pulp for endodontic applications and bone for craniofacial reconstruction is reviewed, and new approaches are identified (Albuquerque *et al.*, 2014; Dissanayaka *et al.*, 2014; Guo *et al.*, 2014). The use of nanotechnology to produce ion-releasing

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particles, tubes, and fibers for delivering appropriate growth or antimicrobial agents is a common theme in these works.

This issue points out the tremendous promise of current approaches to engineer new materials for the repair and replacement of oral tissues, and it highlights the significant advances to date. It is no longer sufficient to simply fill spaces with non-offending or biologically inert materials. The drive for the future is the development of materials that influence their biological environment through defined, controllable pathways that yield predictable clinical outcomes to help our patients (Chirra and Desai, 2012). The level of excitement within the biomaterials research community is obvious. Thanks to all of those outstanding scientists and researchers for contributing to this work. Please enjoy this special issue!

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