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Interface between Materials and Oral Biology

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Historically, lack of toxicity was the primary biological requirement to be considered when placing a material within the body. In recent years, the focus of oral biomaterials research and development has changed to what some describe as a new era of "bioactive" materials, although the word *bioactive* has been used with a lack of specificity and clarity (Darvell, 2021). One may define a bioactive material as one that acts upon or interacts with living cells and tissues to produce a specific response, such as biologically directed mineral formation. This definition implies that mineral precipitation resulting from a supersaturation of an environment having appropriate mixtures of calcium and phosphate ions does not constitute bioactivity, unless directed by cells. Seeding a scaffold or other material with specific growth factors that can be released and taken up by adjacent or contacting cells to trigger differentiation into mineral-forming cells more than likely would be considered a bioactive material. Other examples of potential bioactive materials may be those designed with surface compositions or releasable molecules that act directly on living bacteria to inhibit deleterious biofilm formation. The interactions occurring at the interface between the living cells and the biomaterials constitute critical interactions that define the ultimate result. Examples of the latter 2 types of materials are the subject of articles in this issue. Whether the research and manufacturing communities continue to adopt a broad view of the definition of bioactive materials as opposed to a more focused, narrowly defined one remains a topic of debate.

Understanding the way materials interact with tissues and organisms at the cellular and molecular levels, as well as at a variety of different size scales, is critical for advancing the development of this new generation of materials, as well as for enhancing existing biomaterials. Surfaces and chemistries are being designed to ensure definable biological responses that lead to desirable outcomes, such as enhanced adhesion to dentin or bone for stabilization and interfacial sealing, reducing interfacial degradation mechanisms that compromise the lifetime of polymer-based dental restorations, favorable interactions with the oral microbiota that may transform a system away from dysbiosis and tissue destruction, and stimulation of new mineral formation to replace hard tissues lost due to damage or disease. Specific molecules and cells are being loaded into scaffolds of synthetic or natural materials to facilitate the complete biological regeneration of lost or damaged hard and soft tissues, and new manufacturing strategies are being developed to 3-D print and "biofabricate" live tissue constructs and organoids. This issue will highlight studies describing novel means for probing this interaction between materials science and biology.

This special issue of the *Journal of Dental Research* contains 4 state-of-the-art critical reviews tackling regenerative engineering (Hosseini et al., 2021), oral biomineralization (Moradian-Oldak and George, 2021), advanced testing modalities for dental restorations (Zhang et al., 2021), and the important factors involved in commercializing new innovations in regenerative materials (Taylor et al., 2021). The complex interactions occurring between biomaterials and fluids, as well as living cells and tissues in the oral environment, are highlighted in a series of 17 original research reports. These timely studies address a variety of important issues in oral and craniofacial health. Several articles investigate bacterial adhesion to material surfaces and novel compositions and surface preparation techniques designed to modulate oral biofilm formation (Balhaddad et al., 2021; Lehnfeld et al., 2021; Thongthai et al., 2021). Securing durable adhesion to tooth surfaces using strategies that modify and/or chemically interact with components in the dentin surface is discussed in 3 articles (Alkattan et al., 2021; Cai et al., 2021; Maravic et al., 2021). Biomineralization mechanisms and arrest of carious lesions are explained (Sulyanto et al., 2021). Mineralization as it relates to regeneration of dentin, as well as pulp regeneration with stem cells and innovative scaffolds, forms the basis of 3 additional articles (Chang, Ma et al., 2021; Soares et al., 2021; Zou et al., 2021). A novel pulp–dentin complex "tissue-chip" technology for high-fidelity studies of the tooth–material–microbiome interface is discussed (Rodrigues et al., 2021). Other articles inform on the regeneration of periodontal tissues (Ma et al., 2021) and bone using 3D-printed scaffolds (Chang, Lin et al., 2021). There also are several articles addressing modifications to implant surfaces for the purpose of enhancing bone–implant interactions and minimizing microbial infections at implant sites (Hasani-Sadrabadi et al., 2021; Ko et al., 2021; Rosa et al., 2021; Yang et al., 2021).

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The issue will be of interest to biomaterials scientists, biomedical engineers, oral health researchers, and practitioners. Thanks to all of those outstanding scientists and researchers for contributing to this work. Please enjoy this special issue!

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