Preface

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Published online: 2 August 2019

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Since its foundation in 2018, *Emergent Materials* aimed to focus on evolving techniques/technologies for advanced materials in a wide variety of fields such as polymer science, composites, electronics, membranes, and nano-materials/devices. A popular research area in that respect is biomaterials for medical and biological applications. Therefore, we decided the topic of the first special issue in our journal as *Biomaterials*. Biomaterial is a biological or a synthetic substance, which can be introduced into the body as part of an implanted medical device or used to replace a diseased tissue or an organ. Biomaterials are also used in therapeutic applications such as targeted drug delivery via nano-materials. Therefore, biomaterials vary in size from sub-nano, all the way to whole organ size depending on the application. Biocompatibility is enhanced by incorporation of live cells, an approach known as regenerative medicine or tissue engineering. Despite the substantial potential, there is scarcity of medical applications with biomaterials. This is due to absence of efficient techniques for production of advanced biomaterials. Major challenges to overcome include a decent understanding of the interactions among biological materials, polymers, and natural compounds as well as inorganic materials. Despite recent technological and scientific developments in this emerging field, there are still substantial challenges to overcome mainly relevant to the limited knowledge of the biological, chemical, and physical interactions that come into play in such complex systems. New technologies are needed enabling to investigate these complex interactions and to produce novel materials with superior biocompatibility characteristics. These efforts require application of interdisciplinary technologies.

For the Biomaterials Special Issue, we aimed to create a representative collection of review and original papers that would cover major themes in biomaterials fields. We are glad

to present a total of 11 papers: 9 original research and 2 review. We believe these high-quality papers will introduce journal readers with emerging approaches for development of novel functional biomaterials.

For regenerative medicine, three important components are cells, culture scaffold materials, and scaffold architecture. Cell culture scaffolds needs to have specific characteristics such as mechanical properties and fiber architecture, close to native tissue, and these scaffolds should also be cell friendly enhancing proliferation of resident cells. Therefore, a popular research field is generation of scaffolds from composite materials with synthetic and natural polymers for tuning biocompatibility, biodegradability and strength. *Yalcin and co-workers* produced a set of polylactic acid (PLA)/polyphenol extracted from date palm fruit (DP) blends by electrospinning process to be used as cell culture scaffolds for tissue engineering applications. Authors showed that, addition of polyphenol results in enhanced cell proliferation while maintaining the scaffold strength. *Chatterjee and co-workers* showed that Poly(ester amide)s (PEAs) extracted from olive oil is a potential natural compound for tissue engineering applications, since these polymers have both ester and amide bonds in the polymer backbone offering a combination of desirable properties such as degradability of esters and physio-chemical properties of amides. Titanium implants having some superior properties for tissue replacements have been widely used in biomedical fields. However, the implants are vulnerable to bacterial attacks. *Gumusderelioglu and co-workers* developed a procedure to coat these implants for protection against bacteria. Here electrospinning method was utilized for coating the implants with poly(ethylene oxide) (PEO) nanofibers.

Cardiovascular disorders are among the most important cause of mortality globally. Limited number of heart donations as well as other complications such as transplant rejections necessitates creation of artificial substitutes for failing cardiac tissue. A clear understanding of complex structure of cardiac tissue is required for development of functional biomaterials for cardiac tissue engineering. In this issue, *Zhao and co-workers* elegantly reviewed the current knowledge for the structure of

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the human pericardium and heart wall as well as the compositional details of cardiac extracellular matrix and presented several strategies to obtain cardiac-specific scaffold materials to be used as cardiac patches. Complimentary to this paper, in their review paper, *Serpooshan and co-workers* explained current high-precision manufacturing techniques to generate cardiac grafts. These include traditional techniques such as 3D casting, electrospinning, and self-assembly as well as more modern ones such as additive manufacturing (3D bioprinting).

Regenerative medicine studies require extended in vitro culture of cells under different conditions for the generation of functional tissues. One example condition is hypoxia, in other terms low amount of oxygen exposure. Current approaches for generation of hypoxic environment require impractical complicated systems. *Lin and co-workers* provided a novel approach for hypoxic cell culture that can be easily adapted. Here, glucose oxidase (GOx)–immobilized hydrogels are developed and optimized as an easy and convenient means for creating hypoxia solution in a regular incubator. In a similar attempt to generate hypoxia for cell culture, *Bencherif and co-workers* applied nitrogenation, aiming to prevent oxidization and hence decaying of dopamine, an important bioadhesive precursor for tissue engineering applications. These novel approaches are expected to have a profound influence on similar future studies.

Nano-materials are an important branch of biomaterials and we included one paper in that field in the special issue. *Haik and co-workers* are presenting a new nano-medicine approach against *Staphylococcus aureus*, leading cause of internalized bone infections. Here the authors developed silver-copper-boron (AgCuB) nanoparticle complexes with enhanced anti-bacterial effectiveness.

In the special issue, there are three important works on generation of novel approaches for scaffold architecture

for tissue engineering applications. One major challenge in producing engineered tissue is to match native strength of the tissue while allowing transport of nutrients to the cells and removal of waste from the cells at different layers. *DSouza and co-workers* have developed a novel approach to produce co-axial fibers with porous and non-porous layers offering a new design framework based on natural fibers that can resolve dual needs of mechanical robustness with transport phenomena. *Nazhat and co-workers* on the other hand are presenting a major contribution to osteochondral tissue engineering for joint reconstruction which ideally requires a scaffold system that provides both the articular cartilage and the underlying, supportive subchondral bone. Here, the authors have developed bilayered collagen/chitosan hydrogel to model the osteochondral interface. *Shastri and co-workers* have developed a design strategy to explore potential of newly emerging 3D-bioprinting technique for production of vessel-like structures using extrudable carboxylated agarose hydrogels. Here, parametric design has allowed the creation of new shapes by expressing parameters in an algorithm that defines the relationship between design intent and design response. A hollow bioprinted object was designed and developed and then imaged via x-ray for validating the approach.

In each of the papers within the special issue, there is a novel contribution of production and utilization of biomaterials for biomedical applications. Our thanks go to the reviewers and editors for their help in bringing this highly informative and competitive issue to fruition. We strongly believe that this issue will help the multidisciplinary community to identify a key direction for the science and technology towards advanced emergent materials in medicine and biology.