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Editorial: The future of biomaterials and bio-inspired materials: an early careers scientist's perspective

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Editorial on the Research Topic
Editorial: The future of biomaterials and bio-inspired materials: an early careers scientist's perspective

The field of biomaterials and bio-inspired materials continues to evolve, addressing critical global challenges through innovation in design, synthesis, and application. Early career scientists have become key drivers in this transformation, contributing novel insights and interdisciplinary methodologies. This Research Topic aimed to highlight their contributions and place their work in the broader context of the field's progression.

This Research Topic presents three exemplary studies that underscore the diversity and potential of biomaterials research. One study by Li et al. synthesized pH-sensitive CHX@SBA-PDA nanoparticles, integrating them into a commercial dentin adhesive to evaluate antibacterial performance, cytotoxicity, and bonding properties (Li et al.). These nanoparticles exhibited excellent pH sensitivity, releasing chlorhexidine efficiently under cariogenic conditions, with a release rate of 71.1% at pH 5.0 after 24 h. The functional adhesive demonstrated significant long-term antibacterial activity and improved shear strength compared to the control, without negatively impacting cell proliferation. This work highlights the potential of innovative materials in enhancing the durability of bonded restorations (Li et al.).

Another contribution reported by Rangel et al. focuses on the pivotal role of cell-instructive biomaterials in tissue engineering and regenerative medicine (Rangel et al.). Over the past three decades, significant strides have been made in regenerating diseased or damaged tissues by integrating innovations in biomaterials, signaling molecules, and cell therapies. Despite these advancements, challenges such as material property limitations, the need for advanced manufacturing technologies, and clinical translation hurdles persist. The article highlights breakthroughs in self-healing and modular biomaterials, 3D bioprinting, and emerging research technologies like multi-omics and spatial biology. The perspective offered underscores the critical contributions of clinician-scientists in driving innovation, clinical validation, and adoption of next-generation biomaterials,

emphasizing their transformative potential in tissue and organ engineering (Rangel et al.).

Additionally, a study on pneumatic, fabric-reinforced inflatable soft actuators made of Dragon Skin 30 silicone provides insights into material endurance and variability (Bui et al.). The research elucidates how material properties affect actuator performance over time by examining repeatability, durability, and failure pressure. These findings contribute to a deeper understanding of the real-world behavior of soft actuators and their material constraints, enabling improved design and control in practical applications (Bui et al.).

The overarching aim of this Research Topic was to provide a platform for early career scientists to share their innovative contributions while fostering an understanding of their work within the larger scientific community. The articles included here reflect the broad applicability and interdisciplinary nature of biomaterials and bio-inspired materials, emphasizing their importance in creating sustainable and functional solutions. The collective findings illustrate significant progress in the synthesis, design, and application of these materials, demonstrating their potential to address pressing global needs in healthcare, environmental sustainability, and beyond.

The compilation of studies in this Research Topic exemplifies innovative approaches to biomaterial development, such as the pH-responsive dentin adhesives and cell-instructive biomaterials, which address both performance enhancement and sustainability in practical applications. Early career scientists are uniquely positioned to lead this charge, leveraging their creativity and openness to novel approaches. The insights shared in this Research Topic highlight their essential role in shaping the field's future and provide a glimpse into the directions that biomaterials research is likely to take. However, the insights shared also illuminate persistent challenges, such as the scalability of self-healing biomaterials, the durability and stability of soft actuators, and the clinical translation of tissue engineering technologies. Addressing these challenges requires precise understanding of the structure and function of biological systems to translate them into bioinspired materials effectively as well as interdisciplinary collaborations and advancements in manufacturing techniques, such as 3D bioprinting and high-throughput material characterization methods.

For early career scientists, there are vast opportunities in exploring areas such as bio-inspired 3D printing, the development of multifunctional biomaterials, and the application of machine learning in material design. Collaborations across disciplines and with industry partners can accelerate the translation of these materials into real-world applications. By focusing on underexplored niches like low-cost sustainable biomaterials or modular designs for regenerative medicine, early career researchers can carve impactful pathways for future advancements.

The editorial team extends its gratitude to the authors, reviewers, and collaborators who contributed to this Research Topic. Their collective efforts have ensured that the work presented here reflects the highest standards of scientific rigor and relevance. This Research Topic stands as a testament to the ingenuity and dedication of early career researchers, serving as both a snapshot of current advancements and a catalyst for future innovations in biomaterials and bio-inspired materials research.

As editors, we believe that the findings presented here underscore the transformative potential of biomaterials and bio-inspired materials in addressing global challenges. The pioneering work of early career scientists featured in this Research Topic serves as a beacon for future research. The integration of innovative material properties, sustainable practices, and interdisciplinary approaches is not just a necessity but a pathway to breakthroughs that can redefine the field. We hope this compilation inspires further exploration and collaboration among researchers, particularly early career scientists.

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