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Editorial

Frontiers in Antimicrobial Biomaterials

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Biomaterials can be used as implantable devices or drug delivery platforms, which have significant impacts on the patient's quality of life. Indeed, every year, a substantial number of new biomaterials and scaffolding systems are engineered and introduced in the biomedical field, with increased health benefits observed, as reported by Spalek et al. [1]. However, their long-term use can be threatened by the adhesion and proliferation of microorganisms, which can interact and form biofilms, or by the formation of fibrosis and consequent triggered cytotoxic responses. Pathogenic microorganisms may cause local infections and lead to implant failures. Additionally, they can hinder the delivery of therapeutic molecules by specialized carriers, rendering them ineffective. Many alternatives have been proposed over the years to prevent such events, including the use of antiseptics and antibiotics or the physical modification of the biomaterial surface, with the incorporation of biomolecules having developed into an area of interest. From specialized polymers and functional groups to silver and, more recently, antimicrobial peptides and natural extracts, different functionalization and modification techniques have been employed in this fight against pathogenic agents [1–7]. Marin et al., for instance, introduced a new generation of collagen-based biomaterials embedded with nanoclay for skin regeneration, demonstrating an improved antimicrobial potential. They reported that, depending on the nanoclay type used, both the cellular viability and antimicrobial activity (potentiated by gentamicin) could be controlled for a prolonged action over time [8]. This Special Issue aims at furthering our understanding of the antimicrobial actions of specialized biomaterials and introducing new surface modification strategies, original polymeric chemical structures, and new antimicrobial agent–material combinations, from which infection control or microbial eradication can be achieved.

In this collection of research, many important findings can be highlighted, namely the engineering and synthesis of novel antimicrobial agents. Fadaka et al. took a well-known nanomaterial, the silver nanoparticles, and modified its synthesis to improve its physical-chemical properties. They used gum arabic, sodium borohydride, and their combination as reducing agents and evaluated the particles' antimicrobial and cytotoxic profiles. Gum arabic was deemed to be the most effective reducing agent in improving the bactericidal efficiency of the synthesized silver nanoparticles. However, the authors concluded that the nanoparticle toxicity could not be completely overcome, even by using a greener synthesis methodology, which is required in order to establish ranges of effectiveness for human safety [9]. Novel aminothiazoles with superior antiviral, antioxidant, and antibacterial activities were also synthesized by Minickaitė et al. They demonstrated that, by using substitutes in the thiazole ring, optimized antimicrobial structures could be generated with target specificity [10]. Yussof et al. revealed similar outcomes when exploring the antibacterial and sporicidal effectiveness of theaflavin-3,3′-digallate. They determined the potential of this polyphenol, derived from the leaves of *Camellia sinensis*, to fight against a range of bacteria, including the spore-forming *Bacillus* spp., and established its promising broad-spectrum antibacterial and anti-spore activities [11].

Antimicrobial peptides are considered a new generation of antimicrobial agents. Indeed, in recent years, they have been explored as potential alternatives to antibiotics and

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other immunomodulatory drugs [12]. Umehara et al. studied the well-characterized skin-derived human β-defensins antimicrobial peptides and demonstrated their influence on the secretion of angiogenin, a potent angiogenic factor. They revealed that various human β-defensins can stimulate the production of angiogenin while maintaining their antimicrobial activities and other immunomodulatory properties [13]. Zhu et al. identified a new antimicrobial peptide gene, the Sparanegtin gene from the mud crab *Scylla paramamosain*, whose transcripts were particularly abundant in the testis of that species. The recombinant Sparanegtin was found to be effective against both Gram-positive and Gram-negative bacteria, including *Pseudomonas aeruginosa*, and its immunomodulatory effects on specific bacteria were also revealed [14]. Yang et al. also identified two male-specific antimicrobial peptides, SCY2 and Scyreprocin from the mud crab *Scylla paramamosain*, and established their dual role in reproductive immunity and sperm acrosome reactions while maintaining their antimicrobial profiles [15].

In light of the size and sensitivity to physiological conditions of most bioactive agents, including antimicrobial peptides, optimizing their localized and target deliveries are essential. With this in mind, Yang et al. proposed the incorporation of ClyF, an anti-staphylococcal lysin, into constructs of silica-binding peptide for application as device coatings for the prevention of *Staphylococcal*-related infections. The ClyF-immobilized surfaces supported the normal attachment and growth of mammalian cells and displayed significant bactericidal features, being deemed potentially effective in preventing the growth of antibiotic-resistant microorganisms [16]. In turn, Egle et al. studied the influence of an engineered platelet-rich fibrin, used as a carrier matrix in the antibacterial properties of clindamycin phosphate, on Gram-positive bacteria. The carrier was observed to induce structural changes in the clindamycin, giving rise to a more active compound that significantly decreased the minimal bactericidal concentrations required to eliminate *Staphylococcal* strains. The researchers attested to the safety of the engineered carrier for human cells in vitro, thus evidencing the system's potential to reduce the risk of postoperative infection [17]. Finally, Lee et al. proposed the controlled storage and release of nitric oxide from metal organic nanosized frameworks formed from Cu-BTC for prospective uses in drug delivery systems. The nitric oxide release was maintained as constant for 12 h, meeting the requirements for clinical applications. Most importantly, the authors verified the structures' antibacterial potential by their significant elimination of six bacteria strains, highlighting the synergistic effects between the payload and carrier [18].

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