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Editorial: Biodegradable polymers for biomedical applications-Volume II

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Editorial on the Research Topic
Biodegradable polymers for biomedical applications-Volume II

Degradable polymers are desirable due to their capacity to undergo breakdown, excretion, or resorption without requiring removal or surgical alteration (Kirillova et al, 2021). Designing biodegradable polymers for biomedical applications involves vital considerations such as mechanical properties, chemical properties, and degradation mechanisms (Mukherjee et al., 2023). Biodegradable polymers have been extensively employed in biomedical applications due to their unique properties, such as variable copolymer block composition, surface charge, and film-forming capabilities (Pires et al., 2023). The articles featured in this Research Topic focus on the latest and most promising advancements in biomaterials for controlled drug delivery, tissue engineering, and various biomedical applications.

The considerable interest in poly-lactic acid (PLA) and other biodegradable polymers stems from their natural degradation capability, which eliminates the necessity of a second surgical procedure for removal, unlike non-biodegradable materials such as Polymethyl methacrylate (PMMA) (da Silva et al., 2018). The heat generated during the preparation of PMMA beads could compromise the stability of combined antibiotics for treating chronic osteomyelitis. Liu et al. examined the advancements in research on drug delivery systems based on biodegradable polymers for treating chronic osteomyelitis. The article highlights the utilization of natural biodegradable polymers like collagen, chitosan, and silk protein, as well as synthetic polymers such as PLA, poly(trimethylene carbonate) (PTMC), poly(ε-caprolactone) (PCL), and poly(lactic-co-glycolic) acid (PLGA) for developing delivery systems capable of locally administering antimicrobial agents to infected sites. PLGA-based micro/nanoparticle drug delivery systems offer promising prospects due to their higher efficiency and reduced adverse effects, resulting in extensive utilization in drug-resistant tuberculosis that occurred due to low plasma concentration of orally administered drugs (Pires et al., 2023). To combat this issue of drug-resistant tuberculosis, Shao et al.

reviewed recent advancements in PLGA micro/nanoparticle delivery systems for enhancing the delivery efficiency of tuberculosis drugs to lesion sites, thereby improving their overall efficacy. The article covers the current research achievements and shortcomings of the PLGA micro/nanoparticles to facilitate the translation of microtechnology/nanotechnology from successful experimental outcomes to clinical practice. Like PLGA, Poly(l-lactide) (PLLA) has attracted attention in tissue engineering and orthopedics due to its favorable mechanical properties, ability to degrade naturally, and ease of processing (DeStefano et al., 2020). However, PLLA has certain drawbacks, including low toughness and a relatively slow degradation rate, which limit its extensive utilization on a larger scale. To alter the structure and properties of PLLA, Fan et al. fabricated membranes using a combination of poly(l-lactide acid-p-dioxanone-glycolide) (PLPG) and stereo complex poly(lactic acid) (sc-PLA). The study aimed to assess the impact of different quantities of sc-PLA on PLLA crystallization within the PLPG matrix and to evaluate the biocompatibility of PLPG copolymers. Additionally, the mechanisms that can enhance the control over the mechanical properties and biocompatibility of the PLGP polymers are also explored to address skin trauma and bone tissue engineering.

Advancements in osteogenesis research, biomaterial development, and material science and technology offer promising prospects for creating ideal materials that fulfill the requirements of human bone repair (Zhang et al., 2019). Yu et al. primarily discussed the emerging developments in the field of synthetic biodegradable polymer materials for bone repair, with a particular emphasis on exploring their antitumor properties. The article emphasizes the potential benefits of integrating composite materials, including polymer substances such as PLA, PGA, PLGA, and PVA. This integration addresses the difficulties associated with postoperative bone defects and patients' risk of tumor recurrence. Apart from PVA, there is a requirement to progress the development of additional allogeneic materials to restore Achilles tendon injuries effectively. Biomedical polymers offer a versatile solution for treating and repairing soft tissues, ligaments, muscles, and organs that have suffered damage from living organisms (Liu et al., 2023a). Zhang et al. developed PTMC films loaded with degradable Doxycycline hydrochloride to enable a sustained and prolonged release of the drug to treat Achilles tendon rupture.

Despite standardized treatment, achieving optimal wound healing remains challenging, and patients still face the risk of amputation (Malone and Schultz, 2022). The direct use of biomaterials continues to pose difficulties in attaining definitive benefits for wound healing. It may even result in minor adverse effects due to the characteristics of their degradation products. Ren et al. provided an overview of the intricate integration of biomaterials with drugs, stem cells, and active agents. The article includes utilizing and evaluating composite biomaterials in clinical trials and exploring research concepts and future investigations focused on addressing wound repair issues in diabetes.

Intrauterine surgery-induced damage to the endometrium frequently triggers alterations in the intrauterine environment's physiological processes, consequently leading to infertility among women in their reproductive years (Lee et al., 2020). Stem cell therapy stands out as the most appealing therapeutic strategy for addressing endometrial damage (Wani et al., 2022). However, stem cell transplantation for endometrial repair continues to face significant long-term challenges in terms of safety and efficacy. These challenges include difficulties in preserving the cells, the potential risk of tumor formation, and transplanted cells often needing higher rates of successful migration to the desired location. To address these issues, Cai et al. provided a comprehensive review of biopolymer-based hydrogels as delivery systems for effectively regulating the microenvironment at the site of endometrial injury. In addition, the article also emphasizes the importance of designing hydrogels that incorporate estrogen, stem cells, and therapeutic factors with multifunctional capabilities. These hydrogel systems should not only facilitate uterine cavity formation but also effectively respond to various external or internal triggers. In response to the limitations of chemotherapeutic drugs in breast cancer treatment, extensive research has focused on nanotechnology-based nano-drug delivery systems (NDDSs) to enable stable and sustained release of therapeutic agents, similar to hydrogels for sustained release (Liu et al., 2023b). Jia et al. summarize the research progress on utilizing hyaluronic acid (HA) as a hydrophilic carrier for encapsulating chemotherapeutic drugs. This approach enables targeted delivery to breast tumors through CD44 targeting, improving drug utilization and reducing systemic toxicity. The article includes a detailed compilation of HA-based NDDSs, modified HA-based NDDSs, and HA nanohybrid NDDS containing organic or inorganic substances as practical approaches for treating, preventing, and diagnosing breast cancer.

In dental implantology, a crucial aim is to achieve a long-term integration of the implant in the alveolar ridge (Liang, 2023). However, bone resorption resulting from traumas and tumors can compromise the successful integration of prosthetic teeth replacements. GBR (Guided Bone Regeneration) is a commonly used technique for correcting horizontal and vertical defects or preserving alveolar sockets following tooth extraction. The barrier membranes used in GBR prevent cells from the surrounding epithelium and connective tissue from entering the site, which allows osteoprogenitor cells to multiply and create new bone tissue at the implant site. Yang et al. provided a thorough overview of the applications of biomaterials in GBR to repair alveolar ridge and discussed the future advancement in barrier membranes. The study envelops the clinical operability, biocompatibility, tissue selectivity, and antibacterial properties required for barrier membranes. The work provided insights into polymeric membranes, non-polymeric membranes, and techniques for preparing barrier membranes. The polymeric and non-polymeric meshes utilized for Pelvic Floor Dysfunction (PFD) exhibit inadequate mechanical properties and a rapid degradation rate (Wu et al., 2020). Consequently, they result in suboptimal anatomical reduction and impose limitations on their clinical application in PFD treatment. Lin et al. featured an article on tissue-engineered repair materials that use cells and other additional cues for treating PFD. The work provides insight into cells, scaffolds, cell-combined scaffolds, and the cross-talk between cells and scaffolds. The use of tissue-engineered repair material to restore the damaged sphincter function in case of stress urinary incontinence and strengthening of the pelvic floor and supporting structures in pelvic organ prolapse has been highlighted.

In conclusion, this Research Topic has presented insightful and innovative reports focusing on the biodegradable polymers for biomedical applications, aiming to provide valuable insights and thought-provoking ideas to professionals interested in biomaterials. With the current trend of organ regeneration and reconstruction, personalized therapy and precision medicine, the design and development of bioactive biodegradable polymers will be the future research focus and development direction. Of course, with the rapid development of materials science and medicine, especially the increasing attention to medical-industrial integration, the challenges of biodegradable polymers require more attention.

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Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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