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Editorial: Biodegradable Polymers for Biomedical Applications

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Editorial on the Research Topic

Biodegradable Polymers for Biomedical Applications

The introduction of biodegradable polymers has redefined medical treatment in an innovative manner due to their high biocompatibility and biodegradability (Toh et al., 2021). Designing biodegradable polymers for biomedical applications involve numerous essential factors such as mechanical properties, chemical properties, and degradation mechanisms (Song et al., 2018). Enzymatic and non-enzymatic breakdown of biodegradable polymers *in vivo*, leaving no foreign material inside the human body post-treatment (Fonseca et al., 2014). The articles in this special issue highlight the most recent and promising biomaterial discoveries in controlled drug delivery, tissue engineering, and biomedical applications.

Polymers such as poly (trimethylene carbonate) (PTMC) have gained significant attention in drug delivery systems (Sanower Hossain et al., 2020). Liu et al. featured an article in which ciprofloxacin hydrochloride was used as a drug model whereas PTMC was a drug carrier for treating chronic osteomyelitis. Ciprofloxacin-PTMC implants were studied *in vitro* and *in vivo* for their release and antibacterial effects. The efficacy of ciprofloxacin-loaded PTMC inserts in treating severe osteomyelitis was validated in that investigation. When used as the biodegradable long-term contraceptive implant carrier, the incompatibility between morphological stability and degradation rate of PTMC prevents this application. To solve this problem, Cai et al. discussed an article in which ternary self-blending films were produced by applying ternary self-blending films to high, medium, and low molecular weight PTMC. The *in vitro* influence of ternary self-blending films on the degradation rate of PTMC was also investigated. The study concluded that ternary self-blending film is an effective approach to more accurately manage the degradation behaviour of PTMC.

The Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) scaffold is a potential three-dimensional biodegradable scaffold for cartilage progenitor cell growth and proliferation (Salomez et al., 2019). Xue et al. investigated the effect of incorporating bioglass within PHBV 3-dimensional porous scaffolds. The study concluded that the bioglass added to PHBV three-dimensional porous scaffolds improves the properties of cartilage progenitor cell-based produced cartilage *in vivo*. Replacing fossil-fuel-derived polymers with biodegradable biobased polymers is essential to the circular bioeconomy method to slow down the dreadful current climate change.

Cyanophycin is a polymer made up of amino acids produced by cyanobacteria and has a wide range of biomedical applications (Kwiatos and Steinbüchel). Kwiatos et al. outlined all *in vitro* and *in vivo* studies related to cyanophycin and described their potential applications.

The blending of biodegradable polymers and biodegradable metals can effectively improve or enhance the properties of the parent materials (Martins et al., 2018). It has been reported that the disintegration of PLGA might result in an acidic medium in local tissues, which impairs bone tissue regeneration and delays the material's degradation rate (Zhao et al., 2021). Metals such as Mg and its alloys have been used in orthopaedic equipment in patients with bone abnormalities. But Mg dissolves rapidly *in vivo*, and the uncontrolled degradation raises the pH of the local environment, affecting the mechanism of osteogenesis (Jana et al., 2022). Based on the complementary physicochemical properties of PLGA and Mg, Wang et al. prepared biodegradable composite material of PLGA and magnesium for treating the bone defects. The study recommended that the PLGA with 10% Mg had efficient osteogenic characteristics and cytocompatibility, it could be used in a variety of therapeutic applications such as bone graft healing and scaffold-based tissue engineering. Besides Mg, zinc and its alloys are essential in tissue engineering. However, the high proportion of zinc ions collected around zinc-based implants becomes a significant challenge in promoting the transfer of zinc and its alloys to clinical applications, which would decrease implant biocompatibility. Surface treatment is an effective method for improving implant biocompatibility by modulating the rate of zinc ion release (Pezzato et al., 2020). Su et al. developed Ca. P conversion coatings on pure zinc to promote biocompatibility. The study concluded that adding PLA/Li-OCP coatings was a promising coating for improving degradation rate and cytocompatibility.

Hydrogels have acquired a lot of attention in drug delivery studies because of their high biocompatibility, degradation rate, and processability (Ahmad et al., 2019). Huang et al. investigated the safety and feasibility of hydrogel-encapsulated multipotent stem cells (MSCs), as well as the improvement of survival, retention, and targeting along with the augmentation of their therapeutic impact. The state of the stem cells encased in the hydrogel was also discussed. For example, the Achilles tendon is frequently injured during athletic training (Chan et al., 2020). Biomedical materials such as polyglycolic acid (PGA), polylactic acid (PLA), etc., are the potential solution in the treatment and healing of soft tissues, tendons, muscles, etc., Zhang et al. summarized the usage of biodegradable materials in the repair of Achilles tendon injuries. The investigated biodegradable polymers were PLA, PLGA, PTMC, and polydioxanone (PDS). The review concluded that Biodegradable polymers containing stem cells or medicines could significantly enhance the healing effect of Achilles tendon injuries. Gelatin-methacryloyl (GelMA) hydrogel is a photopolymer created by attaching photosensitive groups to the side groups of gelatin (Bhattacharya et al., 2020). The effect of concentration of photo-initiator or GelMA, cooling rates, and temperature gradients on pore size have been demonstrated, but the effect of freezing temperatures and time in GelMA hydrogel solution, which could have a significant impact on pore sizes in hydrogels, appears to be overlooked (Celikkin et al., 2018). Liu et al. (gelatin).pdf. investigated the effects of freezing temperatures and times on pore sizes in GelMA hydrogel. The changes in swelling and mechanical properties due to different pore size was also studied. The study concluded that the GelMA hydrogels could have a tunable microstructure by adjusting the freezing conditions, opening many possibilities for tissue engineering applications. Tissue vascularization has long been a significant concern in tissue engineering, as it is crucial for the application and durability of tissue constructions *in vivo*.

Biodegradable polymers have been extensively utilized in 3D printing technology. Ze et al. featured a review article in which basic properties of biodegradable materials typically utilized in indirect 3D bioprinting for vascularization, as well as current advancements in using this technology to vascularize various tissues, were highlighted. The study concluded that with the advancement of biodegradable materials in the future, indirect 3D bioprinting could contribute even more to the advancement in the field of tissue engineering.

Esophageal cancer is a malignant tumour that develops in the oesophagus (Xu et al., 2020). Endoscopic submucosal dissection (ESD) has been recognized as a medical therapy in clinics for early esophageal cancer due to the obvious minimally invasive tumour excision and reduced risk of deterioration Cai et al. A common and significant post-ESD consequence is an esophageal stricture. However, there is currently no clear consensus on managing it successfully. Bao et al. reviewed various oesophagal structure strategies in which biomedical polymers and biomedical derived materials were employed. Initially, the mechanism of the esophageal structure was outlined then-novel biomedical materials prevention strategies were elaborated. The review concluded that biomedical materials have the potential to play a critical role in safely and effectively preventing esophageal stricture after ESD. In addition to the biomedical materials mentioned by Bao et al., Janus particles also have great potential in cancer prevention. Janus particles are non-centrosymmetric colloidal materials with non-centrosymmetric shape, composition, and behavior (Tripathy et al., 2022). Because of the changeable dimension, biocompatibility, and low toxicity of Janus particles, these are widely employed in biomedical disciplines, notably in tumour prevention (Zhao et al., 2009). Feng et al. created Janus particles with the phase transition materials (1-tetradecanol, 1-hexadecanol, and lauric acid) along with polymers in a microfluidic system for sequential and planned drug release at a target location such as tumor tissue. The article concluded that such types of heterologous Janus microparticles with each compartment having different degrading properties, can be used for programmed and sequential drug release.

This special issue covers some recent research on biodegradable polymers for biomedical applications. We believe that the current collection of publications will provide thought-provoking ideas to professionals interested in the topic of biomaterials, as well as serve as a foundational lecture for students and researchers just starting in the field of biomaterials.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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