frontiers | Frontiers in Bioengineering and Biotechnology

TYPE Editorial
PUBLISHED 05 August 2025
DOI 10.3389/fbioe.2025.1661817

OPEN ACCESS

EDITED AND REVIEWED BY
Candan Tamerler,
University of Kansas, United States

*CORRESPONDENCE
Yuqin Ma,
myq9393@sina.com
Wenliang Li,
wenliangl@ciac.ac.cn

RECEIVED 08 July 2025
ACCEPTED 30 July 2025
PUBLISHED 05 August 2025

CITATION
Shao D, Ma Y, Li Y, Xu Q, Li L and Li W (2025) Editorial: Pharmaceutical biomaterials. *Front. Bioeng. Biotechnol.* 13:1661817. doi: 10.3389/fbioe.2025.1661817

Editorial: Pharmaceutical biomaterials

Donghan Shao[1,2], Yuqin Ma[1,2]*, Yunhui Li[1,2], Qingming Xu[1,2], Leijiao Li[1,2] and Wenliang Li[1,2]*

[1]School of Chemistry and Environmental Engineering, Changchun University of Science and Technology, Changchun, China, [2]Zhongshan Institute of Changchun University of Science and Technology, Zhongshan, China

KEYWORDS

pharmaceutical biomaterials, smart drug delivery, engineered biomaterials, functional biomaterials, tumor immunity

Editorial on the Research Topic
Pharmaceutical biomaterials

1 Introduction

Biomaterial-pharmaceutical convergence advances smart drug delivery. Engineered biomaterials enable precise therapies via biocompatibility/tunability. This Research Topic showcases multifunctional systems through 32 contributions, spanning composites to translational research for clinical translation.

2 Biomimetic structures guiding regeneration

Functional biomaterials integrated into multi-scale bionic designs enable synergistic control of angiogenesis, antibacterial activity, osteogenesis and so on. Wang's 3D-printed silicate scaffold integrates calcium sulfate-Cu^{2+} delivery: rapid calcium sulfate dissolution initiates osteogenesis, sustained silicate degradation maintains support, and Cu^{2+} release enables antimicrobial/angiogenic niches, achieving spatiotemporal bone repair synchronization (Gao et al.). The transform inert materials into dynamic regenerative platforms through structural programming, proving structural precision enables *in situ* tissue rebirth.

3 Nanotechnology reprogramming tumor immunity

Nanotechnological remodeling of the immunosuppressive tumor microenvironment (TME) represents a paradigm-shifting therapeutic frontier. Tian's Mn nanozyme acts as a metabolic surgeon in acidic TME: dual peroxidase/catalase activities decompose H_2O_2 into $\bullet OH/O_2$, inducing ROS ablation while alleviating hypoxia. Liberated Mn^{2+} blocks PD-L1, synergizing with photothermal immunogenic cell death (ICD) to suppress tumors (Yang et al.). Chen' group reviewed some related studies on the hyperthermia-enhanced

checkpoint blockade effect (Xie et al.). Nanomaterials evolve from passive carriers to active TME builders, reshaping the tumor immune environment.

4 Smart drug delivery overcoming pathological barriers

Intelligent nanomaterials enable on-demand drug release matched to disease rhythms via stimuli response, overcoming pathological barriers. Wu et al. developed NIR-triggered Au-Ag-PDA@MSCM nanosystems inducing local hyperthermia-mediated ferroptosis via Acsl4 upregulation, achieving triple precision: spatial (MSCM homing), temporal (photoactivation), and metabolic (Acsl4 hijacking) control. Zheng et al. designed an injectable dual-carrier system: ① Van-loaded Gel combats infection, ② exposed PLGA MPs release DGEA osteogenic peptide during transition, ③ new bone regenerates. Intelligent systems transform into active agents, remodeling microenvironments for full-cycle disease modulation.

5 Conclusion

Collectively, these advances mark a transformative shift toward real-time interactive therapeutic platforms. By converging materials science, biology, and engineering, the field delivers clinically viable solutions that dynamically intercept disease progression, enabling adaptive precision medicine.

Author contributions

DS: Writing – original draft. YM: Supervision, Writing – review and editing. YL: Supervision, Writing – review and editing. QX: Supervision, Writing – review and editing. LL: Writing – review and editing. WL: Writing – review and editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. We acknowledge the support of this work by the Natural Science Foundation Project of Jilin Province Science and Technology Department (No. 20250102095JC) and the International Science and Technology Cooperation Plan of Jilin City (No. 20240601024).

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.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note