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EDITED AND REVIEWED BY
Weihua Li,
University of Wollongong, Australia

*CORRESPONDENCE
Guobin Ding,
dinggb2012@sxu.edu.cn
Yinlong Zhang,
zhangyinlong@ucas.ac.cn
Ruirui Qiao,
r.qiao@uq.edu.au

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Editorial: Smart materials for tumor-targeted drug/gene delivery

Guobin Ding[1]*, Yinlong Zhang[2]* and Ruirui Qiao[3]*

[1]The Key Laboratory of Chemical Biology and Molecular Engineering of Ministry of Education, Institute of Biotechnology, Shanxi University, Taiyuan, China, [2]School of Nanoscience and Engineering, University of Chinese Academy of Sciences, Beijing, China, [3]Australian Institute of Bioengineering and Nanotechnology, The University of Queensland, Brisbane, QLD, Australia

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Editorial on the Research Topic
Smart materials for tumor-targeted drug/gene delivery

Cancer remains one of the most formidable challenges in healthcare, necessitating the development of innovative therapeutic approaches. In the recent years, the emergence of smart materials has sparked excitement in the field of tumor-targeted drug and gene delivery. These advanced materials possess remarkable properties that enable precise and efficient delivery of therapeutic agents to malignant cells while minimizing damage to healthy tissues, holding tremendous potential to revolutionize cancer treatment with their enhanced targeting capabilities, triggered release mechanisms, multifunctionality, and real-time monitoring. While the potential of smart materials for tumor-targeted drug/gene delivery is immense, several challenges need to be addressed, including scalability, long-term stability, regulatory considerations, and cost-effectiveness. Overcoming these obstacles requires collaborative efforts between scientists, clinicians, regulatory agencies, and industry partners to translate smart material-based therapies into clinically viable solutions. By fostering interdisciplinary collaborations and robust research endeavors, we can accelerate the translation of these promising technologies from the lab to the clinic. This Research Topic comprises four articles that explore smart biomaterials for targeted cancer therapy.

Peptide-based drugs have emerged as a promising category of therapeutics, offering unique advantages in terms of specificity, efficacy, and safety. However, these drugs often suffer from limitations such as poor bioavailability and short *in vivo* half-life, limiting their clinical application. In the first article, Huang et al. presented an innovative approach by developing an amphiphilic peptide using D-peptide with immune checkpoint inhibitory effect to self-assemble into a stable nanostructure, designated as CD-NPs. CD-NPs an extended *in vivo* half-life and demonstrated significant efficacy in inhibiting tumor growth in 4T1 tumor-bearing mice by activating the immune response. This research holds great potential for enhancing the therapeutic outcomes of peptide-based drugs. The BH3 peptide has been confirmed to possess anti-tumor activity. However, its application is hindered by challenges such as low cell membrane permeability, vulnerability to proteolysis, and limited rates of endosomal escape. To address these dilemmas, Guo's group introduced a novel approach by developing gold nanoparticles

decorated with BH3 peptide on their surface, termed BH3@AuNPs. BH3@AuNPs exhibited remarkable *in vitro* anti-tumor effects on the A549 human lung adenocarcinoma cell line. Sonodynamic therapy (SDT) is a promising therapeutic approach that utilizes ultrasound waves to activate a sonosensitizer to generate ROS, which directly induces cancer cell death. To enhance the accuracy and effectiveness of SDT and mitigate its side effect, Zhang et al. have made significant progress in the development of a sonodynamic agent based on Metal-Organic Frameworks (MOFs). This agent exhibits enhanced sonodynamic effects when combined with chemical catalysis through the Fenton reaction. The study emphasizes the potential clinical application of Sonodynamic Therapy (SDT) in anti-cancer treatment. The combination of the MOFs-based sonodynamic agent and chemical catalysis demonstrated a remarkable synergistic effect in 4T1 tumor-bearing mice, while causing negligible side effects. Two-dimensional (2D) nano-carriers have gained significant attention in recent years due to their unique properties and potential applications in drug delivery and biomedical fields. The drug loading and drug release characteristics of two-dimensional (2D) nanocarriers play a critical role in determining drug efficacy. Yao et al. prepared a black phosphorus two-dimensional nanomedicine and systemically investigated its physicochemical property consisting of size distribution, drug loading efficacy, drug release and stability under laser irradiation. By systematically exploring these parameters, this study aimed to enhance our understanding of the black phosphorus nanomedicine and its potential as an effective drug delivery system.

To summarize, this Research Topic covers smart materials of peptide-based drug delivery system, MOFs-based nanostructure and two-dimensional (2D) nanocarriers for tumor-targeted drug delivery. The editors anticipate that the Research Topic "*Smart materials for tumor-targeted drug/gene delivery*" will contribute to the research and development in the field of precision drug delivery. We hope that the papers included in this Research Topic will capture broad attention from different disciplines, leading to rapid advancements in the field of smart materials.

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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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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