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EDITORIAL

Cancer nanomedicine for therapy: emerging strategies and expanding perspectives

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Linqi Shi is a Professor and Ph.D. supervisor at the College of Chemistry (Nankai University, Tianjin, China). A recipient of the National Science Fund for Distinguished Young Scholars in 2006, Professor Shi later led an Innovative Team of the Ministry of Education in 2012. His research centers on nanochaperones for protein folding and proteostasis, as well as polymeric nanomedicines for cancer therapy and combating bacterial drug resistance. Professor Shi is Associate Editor of *ACS Applied Bio Materials*, the *Chinese Polymer Bulletin*, and *Ion Exchange and Adsorption*, an Advisory Editorial Board Member of *Polymer Science & Technology* and *ACS Biomaterials Science & Engineering*, and a member of the Editorial Boards of *Giant* and *Chemistry*. With more than 300 papers published in leading journals, including *Nature Nanotechnology*, *Accounts of Chemical Research*, *Journal of the American Chemical Society*, *Angewandte Chemie International Edition*, and *Advanced Materials*, his work has been cited over 10,000 times. His academic achievements further include three books, seven patents, and three research achievements translated into industrial applications. Among his recognitions are the Wiley Biosciences Award (2018), the Outstanding Contribution Award for Biomedical Polymer Materials (2019), and the First Prize in Tianjin Natural Science (2023).

Cancer remains one of the leading causes of morbidity and mortality worldwide. Despite substantial advances in surgery, chemotherapy, radiotherapy, targeted therapy, and immunotherapy, effective treatment of many cancers remains challenging[1]. In clinical practice, therapeutic efficacy is still frequently limited by insufficient drug delivery, inadequate immune activation, treatment-associated toxicity, and the highly complex tumor microenvironment (TME). These factors often interact with one another and together reduce the treatment response[2]. Therefore, there is a continuing need for strategies that can improve therapeutic precision, strengthen antitumor activity, and overcome the biological barriers that restrict clinical benefit.

Nanomedicine has provided important opportunities to address these challenges. Nanomaterials can improve the solubility, stability, pharmacokinetics, and biodistribution of therapeutic agents, while also being engineered to respond to tumor-associated signals, regulate biological processes, and integrate diagnostic and therapeutic functions. As the field of nanomedicine has advanced, cancer nanomedicine has expanded from a delivery-oriented strategy into a broader area of research involving immune modulation, responsive system design, biologically derived therapeutic approaches, and theranostic integration[3]. This special issue of *Cancer Biology & Medicine* brings together seven articles that reflect these developing directions in nanomedicine for cancer therapy.

Several contributions in this issue focus on the role of nanotechnology in cancer immunotherapy. One review presents a mechanistic framework for understanding how nanomaterials can regulate the cancer immunity cycle with a discussion of strategies to enhance antigen presentation, promote T cell priming and infiltration, and modulate the immunosuppressive TME. A related editorial discusses polymer-based antibody conjugation technologies, highlighting how polymer-mediated assembly can improve immune checkpoint blockade, T cell engagement, and the targeted delivery of immunomodulatory agents. Extending these immunoregulatory strategies to the level of smart system design, another article reviews TME-responsive polymeric nanoparticles and summarizes how endogenous tumor-associated signals, including pH, enzymes, redox gradients, hypoxia, and ATP, can be exploited to design smart nanosystems capable of context-dependent activation, controlled release, and regulation of delivery behavior, thereby improving treatment specificity, modulating the TME, and enhancing cancer immunotherapy. Together, these articles show that nanotechnology can support cancer immunotherapy

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through improved delivery and active immune regulation and context-dependent therapeutic responses.

This special issue also includes a review on click chemistry-driven tumor theranostics. This article discusses recent advances in the use of click chemistry for tumor diagnosis, therapy, and integrated theranostic systems. Because of the high selectivity, modularity, and biocompatibility, click chemistry has become an enabling platform for constructing multifunctional systems that integrate imaging and treatment and allowing precise molecular assembly in complex biological environments.

In addition to these areas, the issue highlights emerging biologically derived and inspired therapeutic approaches. One review discusses postbiotics as emerging bioactive agents in cancer therapy with emphasis on direct antitumor activity, immunomodulatory and metabolic functions, and potential to enhance existing treatments, thereby extending current interest in microbiome-related therapeutic strategies. Another article examines tumor biomineralization and proposes that tumor-associated calcification should be viewed not only as a diagnostic or pathologic feature, but also as an actively regulated biological process with therapeutic potential, including artificially induced tumor mineralization as a possible treatment strategy. Together, these studies broaden the conceptual scope of cancer nanomedicine beyond conventional delivery-centered approaches.

Importantly, this special issue also includes a perspective article that offers a critical reappraisal of several prevailing assumptions in cancer nanomedicine. By proposing that tumors with a poor prognosis may represent a distinct category of bacterially infected, drug-inactivating tumors that can also exhibit enhanced permeability to chemotherapeutics, this article challenges the translational value of some widely accepted concepts, particularly the broad reliance on nanoparticle-mediated delivery and the presumed clinical relevance of the enhanced permeability and retention effect in these settings. The authors further argue that, for such tumors, immediate treatment with carrier-free antibiotic–chemotherapeutic combinations may represent a more realistic therapeutic option in some cases than continued reliance on nanodrug optimization alone. This perspective adds an important critical dimension to the issue and underscores the need to assess nanomedicine strategies within specific biological and clinical contexts rather than as broadly applicable solutions.

Overall, the articles that comprise this special issue reflect the broadening scope of cancer nanomedicine, spanning immune regulation, responsive therapeutic systems, programmable theranostic platforms, biologically inspired treatment strategies, and critical reassessment of prevailing assumptions in the field. Continued progress in this area will depend on close integration of materials science, cancer biology, immunology, microbiology, and translational medicine. We hope that this special issue will provide readers with a useful overview of recent advances in nanomedicine for cancer therapy and stimulate further research in this important and rapidly developing field. We sincerely thank all authors and reviewers for their valuable contributions and we are also grateful to the editorial team of *Cancer Biology & Medicine* for their support in organizing this special issue.

Conflict of interest statement

No potential conflicts of interest are disclosed.

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