Editorial

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# Editorial Note on Nano-enabled immunomodulation

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## Editorial

The bubbling area of research in Nano medicine is immunomodulation, which is the tuning of how the immune system responds to exogenous and endogenous risk stimuli. However, the extent in which the immune system functions is staggering. The coordinated behavior of the innate and adaptive arms of the immune system is guided by a complex network of cell types and subtypes. They organize the response to hazard signals by various signaling molecules, and curb the abnormal reaction against self-antigens that occur in autoimmune diseases under healthy conditions.

Therefore, the prospects for Nano-enabled immunomodulation are multiple, and so are the challenges. This problem with Emphasis illustrates a few examples.

The Cifuentes-Rius and co-workers' analysis focuses on approaches to nanotechnology that target dendritic cells (DCs) to induce immune tolerance. DCs are a heterogeneous class of antigen-presenting cells that play a prominent role in maintaining the delicate balance between immunity and tolerance as the point of touch between the innate and the adaptive immune system. Tolerogenic immunotherapies by DC reprogramming aim to induce self-tolerance. In cells removed from patients, which are first cultured in a medium that induces a tolerogenic phenotype and then reinfused into the body, this is typically done ex vivo. Instead, rationally engineered nanoparticles could allow in vivo DC reprogramming. The authors identify the various routes used in animal models to produce tolerogenic responses and their future clinical applications in organ transplants and in the treatment of diabetes mellitus and multiple sclerosis, with the associated challenges.

Another big class of immune cells that are ideal for engineering approaches are T cells, with specific significance for cancer immunotherapy. Like DCs, in a procedure called adoptive T-cell therapy, they can be removed from the blood of a patient, modified, expanded and reinfused into the body to destroy tumour cells (ACT).

As shown by the approval of three chimeric antigen receptor (CAR) T-cell therapies by the US Food and Drug Administration in 2017 and 2020, ACTs carry considerable translational potential. Nonetheless, several bottlenecks obstruct their comprehensive implementation, Such as ineffective in vitro T cell expansion, weak trafficking of target tumors, tumor site T cell fatigue, and loss of targeting antigens on cancer cells. Gong and colleagues address the alternatives to Nano medicine in their study In order to address these problems, it provides the advantages it offers for the future application of ACTs for the treatment of solid tumors and the remaining unanswered questions for its clinical application in T cell immunotherapy.

The task of translating the effects of immuno-oncology Nano medicine from the preclinical to the clinical environment is the focus of Jiang's and his colleagues' perspective. Nano materials can enhance immunotherapy results while reducing their side effects, but their effectiveness ultimately depends on the immune system's tumoricidal capabilities. Consequently, in order to correlate preclinical findings with clinical outcomes, it is important to consider the various variables that could impact the responses of the immune system when designing preclinical experiments. Molecular heterogeneity of tumours, micro biota, gender imbalance, immunosenescence, pseudo progression and systemic toxicity, they are all confusing factors that could impede the clinic's development in nano-immuno medicine. Some of the recommendations suggested by the authors to account for these reasons are to pay more attention to the animal models used for preclinical research, enhance condition monitoring and expand toxicity tests.

The Analysis by Singh offers an overview of how nanotechnology can aid vaccine production against infectious diseases, shifting away from therapy. Via various mechanisms, Nano vaccines may pass the barrier to penetrate the lymphatic system and hit, The lymph nodes' B cell follicles. They will present their antigens to B cells there, facilitating their maturation and eventual differentiation into long-lived plasma B cell secretion antibodies and memory B cells that defend against re-infection. The paper

 

reviews the bioengineering strategies that have created efficient animal models of Nano vaccines and analyzes the current challenges in the field, i.e. the impact of the micro biome on the efficacy of Nano vaccines; the possible exacerbation of the disease by antibody-dependent agents due to suboptimal antibody response; How to design Nano vaccines that produce widely neutralized HIV and influenza antibodies; how to account for virus mutations; and how to scale up the development of Nano vaccines.

Only some of the ongoing research in the field of nano-immunoengineering is seen in this special issue. In addition to the various strategies developed to enhance cancer immunotherapies, Nano immunotherapy methods may also benefit from chronic inflammatory diseases such as atherosclerosis. In addition, in preclinical models, biomimetic methods utilizing nanoparticles coated with leukocyte-derived membranes have recently been used to boost serious inflammatory conditions. Finally, with their uniquely tunable characteristics and the possibility of arranging surface epitopes in particular spatial arrangements, nanomaterials can be used to explore basic aspects of immunology, providing insights into how particular risk signals on pathogens are identified by the immune system and how immune cells communicate with each other6. In exchange, these findings will feed future applied bioengineering efforts.