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Research review paper

Nanoengineering of vaccines using natural polysaccharides

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ABSTRACT

Currently, there are over 70 licensed vaccines, which prevent the pathogenesis of around 30 viruses and bacteria. Nevertheless, there are still important challenges in this area, which include the development of more active, non-invasive, and thermo-resistant vaccines. Important biotechnological advances have led to safer subunit antigens, such as proteins, peptides, and nucleic acids. However, their limited immunogenicity has demanded potent adjuvants that can strengthen the immune response. Particulate nanocarriers hold a high potential as adjuvants in vaccination. Due to their pathogen-like size and structure, they can enhance immune responses by mimicking the natural infection process. Additionally, they can be tailored for non-invasive mucosal administration (needle-free vaccination), and control the delivery of the associated antigens to a specific location and for prolonged times, opening room for single-dose vaccination. Moreover, they allow co-association of immunostimulatory molecules to improve the overall adjuvant capacity.

The natural and ubiquitous character of polysaccharides, together with their intrinsic immunomodulating properties, their biocompatibility, and biodegradability, justify their interest in the engineering of nanovaccines. In this review, we aim to provide a state-of-the-art overview regarding the application of nanotechnology in vaccine delivery, with a focus on the most recent advances in the development and application of polysaccharide-based antigen nanocarriers.

Contents

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1. Challenges and advances in vaccine development

Throughout the last decades, vaccination has played a fundamental role in the prevention of severe infectious diseases, and even in the eradication of some of them. Despite the advances achieved to date, significant challenges still need to be faced in order to gradually increase vaccine coverage. These include not only the development of new vaccines against certain pathogens such as human immunodeficiency virus (HIV), malaria and tuberculosis, among others, but also the development of single-dose and needle-free vaccines intended to improve patient compliance and reduce associated costs. Lastly, the production of formulations that can avoid the cold chain of transport represents a keystone to improve vaccination worldwide. Progress in both antigen and adjuvant development has led to the recognition of the value of nanotechnology to deal with the above indicated challenges. For the preparation of nanovaccines, different immunomodulating biomaterials have been proposed, including polysaccharides. This innovative approach is the main focus of this review and is summarized in Fig. 1.

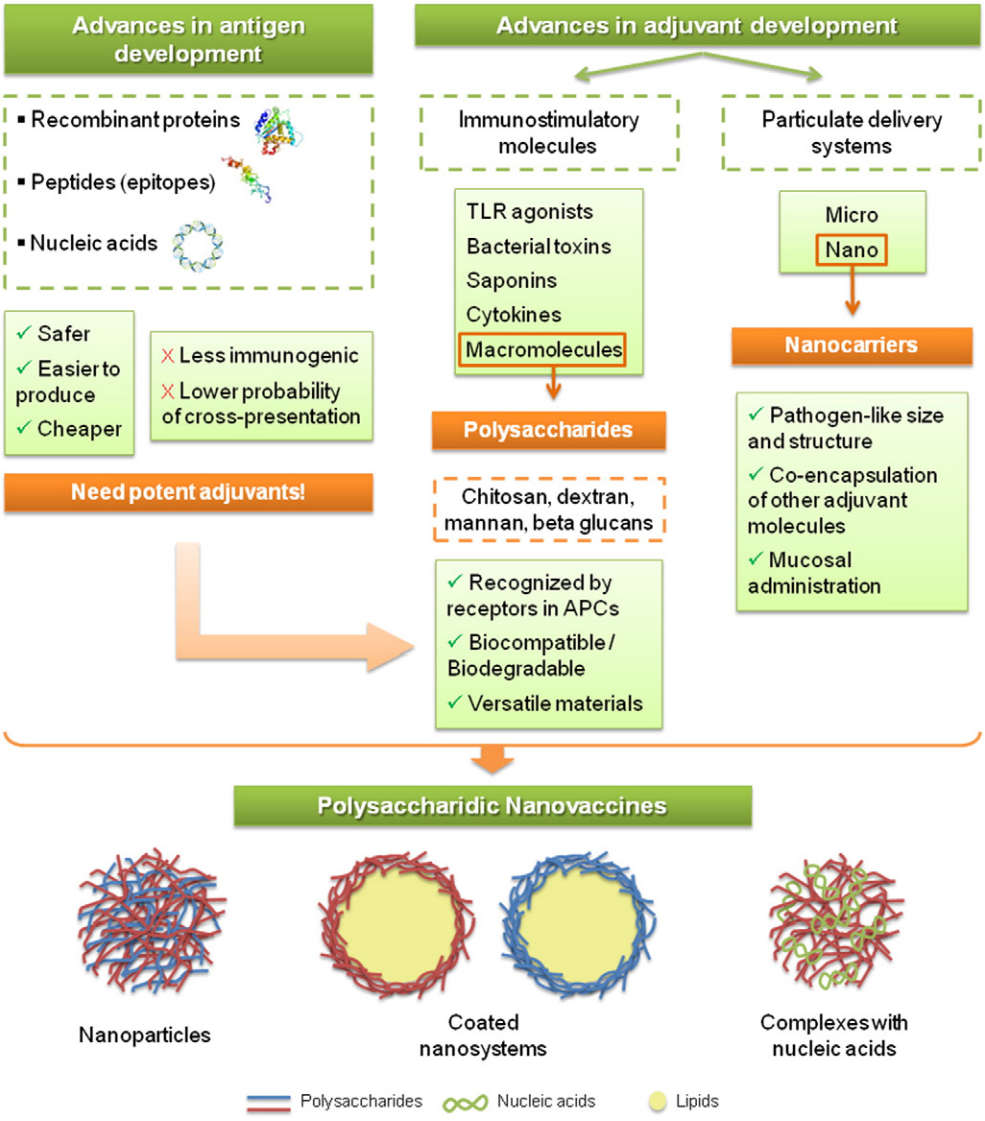

Fig. 1. Advances in biological and microbiological technologies have increased the knowledge of pathogens and led to the development of newer and safer subunit antigens. Nevertheless, these antigens are less effective in inducing protective immune responses and therefore require a parallel development of potent adjuvants such as immunomodulating molecules and particulate delivery systems. Among these, polysaccharide-based nanosystems have demonstrated potential to be successfully used in vaccine formulations.