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Research review paper

Polymer nanotechnology based approaches in mucosal vaccine delivery: Challenges and opportunities

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ABSTRACT

Mucosal sites serve as the main portal for the entry of pathogens and thus immunization through mucosal routes can greatly improve the immunity. Researchers are continuously exploring the vaccination strategies to engender protective mucosal immune responses. Unearthing of mucosal adjuvants, that are safe and effective, is enhancing the magnitude and quality of the protective immune response. Use of nanotechnology based polymeric nanocarrier systems which encapsulate vaccine components for protection of sensitive payload, incorporate mucosal adjuvants to maximize the immune responses and target the mucosal immune system is a key strategy to improve the effectiveness of mucosal vaccines. These advances promise to accelerate the development and testing of new mucosal vaccines against many human diseases. This review focuses on the need for the development of nanocarrier based mucosal vaccines with emphases on the polymeric nanoparticles, their clinical status and future perspectives. This review focuses on the need and new insights for the development of nanoarchitecture governed mucosal vaccination with emphases on the various polymeric nanoparticles, their clinical status and future perspectives.

Contents

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Introduction

Mucosal surfaces, such as gastrointestinal tract (GIT), lungs and reproductive tract are prone to viral and bacterial attacks and serve as entry ports for pathogens. Scientists are continuously working in order to ascertain protection through these surfaces as they constitute the first line of defense against infection. Mucosal vaccines are intended to utilize the elements of the immune responses associated with this route of administration. Development of such vaccines help in providing protection against large number of diseases including influenza, sexually transmitted diseases and other respiratory viruses (L. Li et al., 2013). To date few vaccines have been successfully delivered via mucosal route and the best known example is the orally delivered *sabin* polio vaccine and other examples include mucosal vaccine against rotavirus, cholera and typhoid fever. Conventional vaccines suffer from disadvantages such as degradation followed by clearance from the site sometimes prior to the desired action. The development of nanotechnology based vaccines for mucosal immunization may circumvent these drawbacks. Mucosal route possesses certain advantages over the parenteral route including activation of dual immunity i.e. at mucosal and serosal site. Elicitation of immune response at one site can induce immunization at local as well as distal mucosal surfaces. Nanocarrier may improve the release profile of the loaded antigen and resist degradation in the biological environment, thus improve the efficacy. This review focuses on the polymeric nanotechnology based mucosal vaccines explored for mucosal immunization.

Anatomy and physiology of mucosal immune system

Lymphocytes are important constituent of immune system and approximately 50% are present in the Mucosa-associated lymphoid tissue (MALT). MALT is located along the surfaces of all mucosal tissues. Nasopharynx associated lymphoid tissue (NALT), Gut associated lymphoid tissue (GALT) and bronchus-associated lymphoid tissue (BALT) are the most common representatives of MALT. Different routes of vaccination with associated features and the lymphoid tissue involved are shown in Fig. 1. IgA secretion across the mucosal surface in antigen specific Th2 dependent reaction is mainly governed by MALT. Immune-tolerance is observed sometimes which can be attributed to Th1 and cytotoxic T-cell mediated reactions (Kiyono and Fukuyama, 2004). Functionally MALT can be found at two sites viz., inductive (GALT, BALT and NALT) and effector (Giuliano et al., 2002). Secondary lymphoid tissues are present at inductive sites wherein clonal expansion of B-cells takes place after specific T-cell activation by antigens. Migration of T and B cells from inductive to effector site occurs after IgA class switching. Effector sites are present in all mucosal tissues as scattered lymphoid tissue diffused throughout the substantia propria or lamina (Yan et al., 2003). Dendritic cells (DCs), macrophages, T-

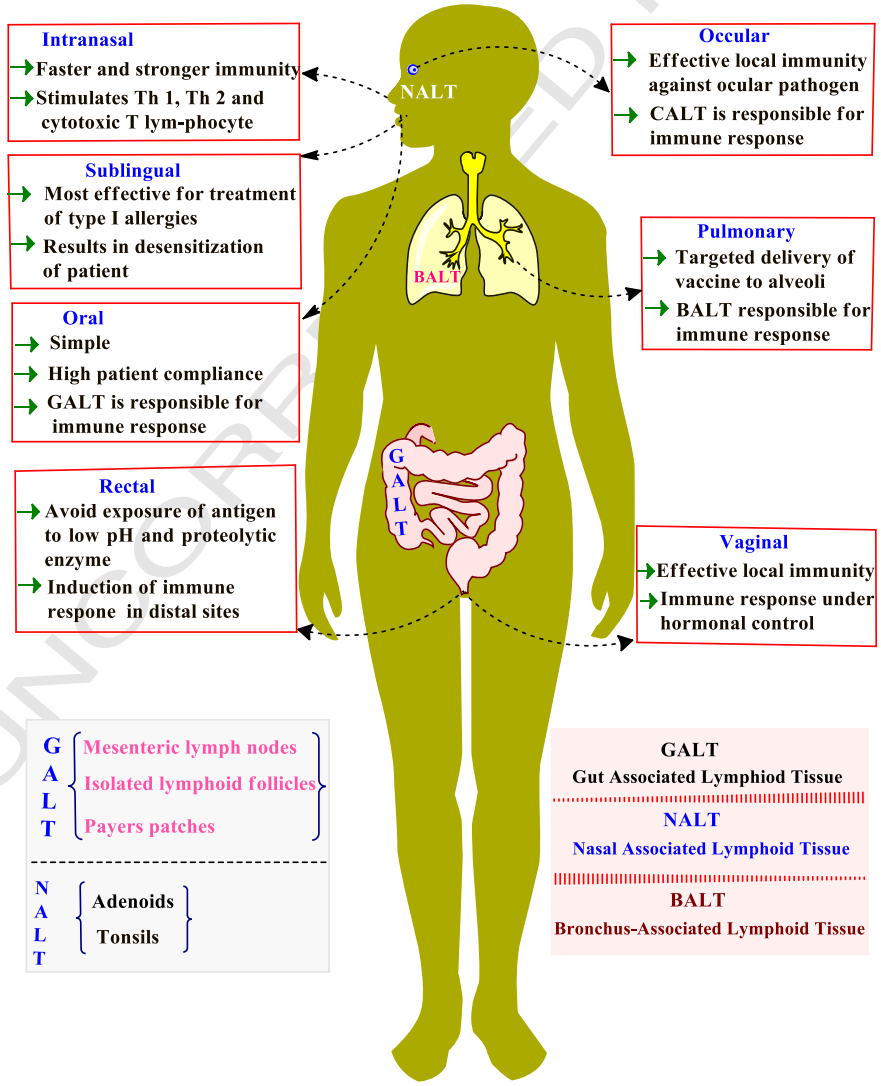

Fig. 1. Schematic representation of various routes and lymphoid tissue present at mucosal sites.

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