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Nanoparticles as Immunomodulator

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ABSTRACT

Nanoparticles are characterized as dispersed or solid particulate having diameter ranges from 1 to1000nm. Since the last few decades hydrophilic polymer coated biodegradable nano-polymer are being applied as prospective drug delivery vehicle. Numerous external and internal atmospheric factors provoke infections in host; which is shielded by normal immune functions. The functions of immune system may perhaps be activated or restrained by certain aspects. The present review article was aimed in searching of a new light on the role of nanoparticle in immunomodulation. During infection, body's immune resistance is subsidiazed by Immunosuppression. The function of B-cell in alveolar macrophages is repressed by Carbon nanotubes through the production of TGF-β, which is a key reason of immunosuppression. Antigen loaded with nanoparticle provokes the secretion of interferon-γ and IL-4 cytokines in immunological cells.

Keyword: Nanoparticle, antigen, immune system, immunomodulation

Nanoparticles

Nanoparticle is described as dispersed or solid particles within range of 1-1000nm in size. Melted and lured drug is attached to a nanoparticle and applied for drug delivery (Langer, 2000). Through altering the method of preparation nanoparticles, nanospheres or nanocapsules can be prepared. Drug is impounded to exceptional polymer membrane enveloped cavity in case of nanocapsules; whereas drug is physically and uniformly dispersed are nanospheres (Veronese and Pasut, 2005). In current trends of research, hydrophilic polymer coated biodegradable polymeric nanoparticles (such as polyethylene glycol) has the capacity to circulate drug in target organ for a prolonged period; carriers DNA in gene therapy; delivers proteins, peptides, genes; and being considered as long-circulating potential drug delivery vehicle (Kommareddy et al., 2005). Nanoparticles are prepared from proteins, polysaccharides and synthetic polymers. The Matrix materials of nanoparticles is selected based on the size of required nanoparticles, inherent properties of drug, surface characteristics such as charge, permeability, and degree of biodegradability, biocompatibility and toxicity (Lee and Kim, 2005).

The Immune System

The host gets protection from pathogens through immune system, which admirably refrains to assemble swing compulsions of the body to respond the environment. The immune system, in terms of immune functions is able to be agitated at diverse planes; result of either suppression or overstimulation of the immune functions. Advanced chemical and biological creatures bring about sufficient explorations about the dealings of immune system before industrial, biological and medicinal

applications. The immune system is a vibrant set-up of living cellular system. Immune system secured host against 'foreign' trespassers by recognizing 'self' and 'non-self cells and thus save the host from harmful diseases (Cavagnaro, 2002).

The immune system exercises specialized cells to identify the infiltrators; which combat against antigen to abolish the infiltrators. Such type of recognition by the immune system is sometimes confusing due to quick evolving of pathogens inside the host through fast adaptation, which ultimately evades the immune functions; and result of survival of pathogens inside the host and develops infection (Casadevall and Pirofski, 2000). Cytokines are usually small secreted proteins; also known as cell signaling molecule, that plays a crucial role for enhancement of innate and adaptive immunity. Cytokines are expressed as lymphokines (cytokines produces by lymphocytes), monokines (cytokines produces by monocytes), chemokines (cytokines with chemotactic behaviors) and interleukins (cytokines produced by one leukocyte to act on other leukocytes). Cytokines may exhibits autocrine action (cytokine acts on the cell from where it produces), paracrine action (cytokine acts on the nearby cells) and endocrine action (cytokine diffuse through circulation and acts on distinct cell). Cytokine ties with specific membrane receptor in host cell that produces an intracellular signaling cascade; result of improvement of cellular functions (Witzmann and Monterio-Riviere, 2006).

Immunomodulation

Immunomodulation is termed as the achievement of auto-regulating processes by medication that shoves the immunological defense mechanism. Several therapeutic effective and safe anti-homotoxic medication are more useful as immunomodulators. Formulated micro/nano doses anti-homotoxic medications are excluded from intoxication by therapeutic constituents due to their blocking properties. Macro doses anti-homotoxic medications occasionally shows the signs of side effects or interactions with other medications or stuffs like alcohol (Dietert, 2005).

Immunomodulation by nanoparticles

Modulation of immune system occurs by two ways: immunosuppression and immunostimulation.

Immunosuppression

Immunosuppression may be either accidental or desirable. Immunosuppression may subordinate the defense mechanism of body against infection. It increases the therapeutic benefits of treatments for allergies and autoimmune diseases. It also prevents the rejection of transplantation. A few traditional toxicology nanoparticles studies spotlighted the detrimental corollary of immunosuppression. Studies revealed that the inhalation of carbon nanotubes suppresses the B-cell functions and generates TGF-β in alveolar macrophages, a key factor for immunosuppression (Mitchell et al., 2009). Nanoparticles can be used in sorts of small-molecule drug delivery vehicle to prevent immunosuppression. Study also reported that PLGA nanoparticles were used to deliver glucocorticoids to the inflamed joints in arthritis mouse model. Immunosuppression is arbitrated by T-cells toxicity substances. Tetrachlorodibenzo-p-dioxin, cadmium, corticosteroids, and radiation are active on T-cells and wane their maturity and efficacy; hence known as potent immunosuppressive agents (Higaki et al., 2005).

Immunostimulation

Based on the capability to excite the immune function, the immunostimulatory prospective of several nanoparticles have been extensively estimated in several studies. The corollary of nanoparticles on complement system, cytokine and antibody production response has been reported earlier. Due to improvement of antigenicity of conjugated weak antigens and as antigenic adjuvants, the immunogenicity of nanoparticle is a enormous interest in the

cutting edge research of current century (O'Hagan and De Gregorio, 2009). This property depends on the size and surface charge of nanoparticle, for contribution to the development of better vaccine preparation. It was reported that particle size grasp a chief responsibility for loading of antigens into nanoparticles, that induces the production of type I (like interferon-γ) or type II (like IL-4) cytokines to facilitates the immune response. In spite of several research reports, the antigenic property of nanoparticles is not clear till now. A hypothesis was reported that in a case of *in vivo* environment, the nonsoluble nanoparticles afford powerful and purposeful release of antigens to form a depot and provide protection (Panyam and Labhasetwar, 2003). It was reported that during vaccination, a strong adjuvant i.e., BSA conjugated C^{60} fullerene derivatives produces nanoparticle specific antibodies. Studies also reported that inspite of presence of powerful adjuvants, the unusual fullerene derivatives (such as gold colloids, cationic polyamidoamine and polypropyleneimine dendrimers) have no particle specific immune response. BSA conjugate polyamidoamine dendrimers produces *in vivo* antigenic response (Braden et al., 2000).

Abbreviations:

BSA: Bovine serum albumin
DNA: Deoxyribonuclic acid
IL-4: Interleukin-4
PLGA: Poly (lactic-co-glycolic acid)
TGF-β: Tumor growth factor- β

Declaration of interest

The author reports no conflicts of interest. The author alone is responsible for the content and writing of the paper.

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