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Immune Response of Biopolymeric nanoparticulate systems

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ABSTRACT

N*anotechnology refers to research and technology development at the atomic and molecular scale, leading to the controlled manipulation and study of structures in the 'nanometer' size, normally ranging from 0.1-100nm. The trick of successful nanoparticle-based therapeutics is to avoid immunostimulatory or immunosuppressive reactions to the nanomaterials once administered into the body. 'Immunostimulation' means avoiding that the immune system efficiently recognizes the particles as foreign substances and mounts a multilevel immune response against them. 'Immunosuppression' involves an act, e.g. the effect of a drug that reduces the activation or efficacy of the immune system. However, as nanoparticles represent physically and chemically diverse materials, the classical methods cannot always be applied without modification, and novel approaches may be required.*

Keywords: *Immunostimulation, Nanomaterials, Nanotechnology, Immunomodulation.*

INTRODUCTION

Nanotechnology refers to research and technology development at the atomic and molecular scale, leading to the controlled manipulation and study of structures in the "nanometer" size, normally ranging from 0.1-100nm - the same basic size as small as biological entities (Riehemann, K. *et al*, 2009). The area of nanomaterials has been increasingly expanding during the last decade, ranging from optical systems, electronic, chemical industries, to environmental engineering and medicine (Riehemann, K. *et al*, 2009), which up to now has resulted in approximately 800 nanoparticles-containing consumer products (Marquis, B. J. *et al, 2009)*. This new class of advanced materials posseses special properties including large surface area to volume ratio, whereby the materials take on novel properties compared to those seen in the bulk scale, such as dramatic changes of their magnetic, physicochemical, and electronic properties (Muhammed, M. 2003). Nanoparticles offer ability to interact with complex biological functions at the scale of biomolecules, implying enormous opportunities for novel applications in medicine, including diagnostics, medical imaging, targeted delivery and immunotherapy. Nanoparticles are increasingly being investigated in drug delivery as they can potentially carry their payload directly to diseased cells or tumours with a reduced dosage and therefore fewer side effects. Scientists have designed 'stealth nanoparticles' that can deliver drug payloads without detection by the immune system, thereby preventing adverse reactions. The trick of successful nanoparticle-based therapeutics is to avoid immunostimulatory or immunosuppressive reactions to the nanomaterials once administered into the body. 'Immunostimulation' means avoiding that the immune system efficiently recognizes the particles as foreign substances and mounts a multilevel immune response against them. 'Immunosuppression' involves an act, e.g. the effect of a drug that reduces the activation or efficacy of the immune system. It is usually induced to prevent the body from rejecting an organ transplant or for the treatment of auto-immune diseases. Undesirable immunosuppression may decrease body's own defense against pathogens and cancerous cells. Our immune system constantly interacts with our internal environment, protects us from our external environment and provides the inherent knowledge to sense the difference between '*friend and foe'* with important implications in human health and disease (Pozo, 2008). Nanoparticles can also be designed to elicit an immune response by either direct immunostimulation of antigen-presenting cells or delivering antigen to specific cellular compartments (Kalkanidis M *et al* 2006). Nanoparticle-mediated immunostimulation and immunosuppression is imperative to make effective delivery systems.

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CONCLUSION

In summary, existing studies have demonstrated that nanotechnology offers many advantages, such as improved stability, favorable biodistribution profiles, slower drug release kinetics, lower immunotoxicity, and targeting to specific cell populations. Lessons learned from previous studies include the importance of detection and prevention of potential particle contamination with such things as bacterial endotoxins and/or toxic synthesis by-products, and the importance of understanding how route of administration and particle biodistribution in the body may result in either desirable and undesirable immunomodulation (*e.g*. complement activation on iv administration is not desirable, whereas on sc administration, it is beneficial for vaccinations).

The main challenge in immunological studies of nanomaterials is choosing an experimental approach that is free of false-positive or false-negative readouts. The majority of the standard immunotoxicological methods are applicable to nanomaterials. However, as nanoparticles represent physically and chemically diverse materials, the classical methods cannot always be applied without modification, and novel approaches may be required.

Although in recent years, our understanding of nanoparticle interaction with components of the immune system has improved, many questions still require more thorough investigation and deeper understanding. Further mechanistic studies investigating particle immunomodulatory effects (immunostimulatory and immunosuppression) are required to improve our understanding of the physicochemical parameters of nanoparticles that define their effects on the immune system.

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