Biomedical nanopacarriers: the importance of size and surface charge in modulating the pulmonary immune system

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Due to its vast surface area provided by the gas exchange region, limited local proteolytic activity, non-invasiveness, fine anatomical barriers for systemic access and a number of different antigen presenting cell (APC) populations, the respiratory tract is an attractive target for the delivery of vaccine antigens. Nano-sized carriers have been proposed as promising novel diagnostic, therapeutic, and vaccination approaches for a variety of human diseases. Pulmonary APC are considered as sentinels of the immune system due to their strategic localization, their phagocytic activity, and their ability to present antigen. To improve efficiency of vaccination and develop new strategies, a well-founded knowledge about composition and characterization of APC populations throughout the respiratory tract is essential. In particular, respiratory tract dendritic cells, as key APC in the lung, constitute an ideal target for vaccine delivery. Furthermore, carrier size is a key factor when designing new inhalable vaccines, as size determines not only deposition in different respiratory tract compartments, but also how an antigen and its carrier will interact with lung tissue components and immune cells. Recent studies have also emphasized the importance of particle surface charge, when interacting with biological interfaces, since charge may strongly affect interactions with cells, e.g. regarding rate of uptake and intra-cellular trafficking. Clarifying which APC / dendritic cell populations primarily interact different sized and charged nanocarriers and traffic these from different respiratory tract compartments to lung draining lymph nodes is paramount to understanding related downstream inflammatory and immune responses. Such data will be fundamental to rationally develop future novel particulate systems in the nano-size range for therapeutic or diagnostic applications in the respiratory tract.

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