Development of Vaccine Adjuvants Using Polymeric Nanoparticles and Their Potential Applications for anti-HIV Vaccine

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The development of a prophylactic/therapeutic HIV-1 vaccine based on recombinant proteins is needed for the control of the worldwide AIDS epidemic. Subunit protein and peptide vaccines are generally very safe vaccines with well-defined components. However, these antigens are often poorly immunogenic and thus require the use of adjuvants to induce adequate immunity.

Particulate adjuvants (e.g. micro/nanoparticles, emulsions, ISCOMS, liposomes, virosomes, and virus-like particles) have been widely investigated in HIV-1 vaccine delivery systems. Antigen uptake by antigen-presenting cells (APCs) is enhanced by the association of antigens with polymeric micro/nanoparticles. The adjuvant effect of micro/nanoparticles appears to largely be a consequence of their uptake into APCs. More importantly, particulate antigens have been shown to be more efficient than soluble antigens for the induction of immune responses.

For the past two decades, we have studied the synthesis and clinical applications of core-corona polymeric nanospheres composed of hydrophobic polystyrene and hydrophilic macromonomers. Core-corona type polymeric nanospheres have applications in various technological and biomedical fields, because their chemical structures and particle size can be easily controlled. In this study, we focused on the development of HIV-1 vaccine using polymeric nanoparticles. We evaluated immunization strategies of HIV-1-capturing core-corona type polystyrene nanospheres that would efficiently induce HIV-1-specific IgA responses in female mice or macaques genital tract. Moreover, based on these research, we attempted to develop a new biodegradable nanoparticles composed of poly(γ-glutamic acid) (γ-PGA) for protein-based vaccine delivery. These protein-loaded γ-PGA nanoparticles showed unique potential as a vaccine carrier.