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A polyanhydride-based implantable single dose vaccine platform for long-term immunity

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A polyanhydride-based implantable single dose vaccine platform for long-term immunity

Abstract

Traditionally, immune priming followed by an antigen-boost is utilized for vaccine-induced protective immunity and maintaining long-term immunity often requires repeated exposure to antigen. Here, a novel single dose vaccination platform designed with gonadotropin releasing hormone multiple antigenic peptide as a model antigen is shown.

Disciplines

Biomedical Engineering and Bioengineering | Large or Food Animal and Equine Medicine | Veterinary Pathology and Pathobiology | Veterinary Preventive Medicine, Epidemiology, and Public Health

Comments

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A polyanhydride-based implantable single dose vaccine platform for long-term immunity



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Traditionally, immune priming followed by an antigen-boost is utilized for vaccine-induced protective immunity and maintaining long-term immunity often requires repeated exposure to antigen. Here, a novel single dose vaccination platform designed with gonadotropin releasing hormone multiple antigenic peptide as a model antigen is shown. Initially a soluble component will prime the immune system followed by vaccine release from a biodegradable polyanhydride (PA) copolymer rod of 1,8-bis(*p*-carboxyphenoxy)-3,6-dioxaoctane (CPTEG) and 1,6-bis(*p*-carboxyphenoxy) hexane (CPH) for immune boosting (Appendix A) [1]. A second PA-based vaccine depot is enclosed within an implant of biocompatible high molecular weight polyethylene, which limits PA degradation and antigen release to a single surface, significantly extending the release kinetics (Supplemental Table). Collagen is used to generate an immunodiffusion barrier [2] over the PA wherein antigen-antibody complex formation can occur for an immune feedback design (Fig. 1). Therefore, antigen release is impeded, theoretically, by high antibody titers. The cap of the implant is a hydrophilic poly(vinylidene fluoride) membrane with 0.65- μ m pores that allows flow of proteins into and out of the implant, while excluding leukocytes. Thus, this device enables vaccine priming, boost and long term maintenance with a single administration of antigen.

Acknowledgments

Patent # 14/814,148 - *Vaccine Delivery Devices* is pending. This work was supported by an Iowa State University Bailey Award, the Nanovaccine Institute, and a grant from Michelson Prize & Grants, a program of the Michelson Found Animals Foundation, which is supported by the generous contributions of Dr. Gary Michelson and Alya Michelson. B.N. acknowledges the Vlasta Klima Balloun Faculty Chair.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.vaccine.2017.11.067>.

References

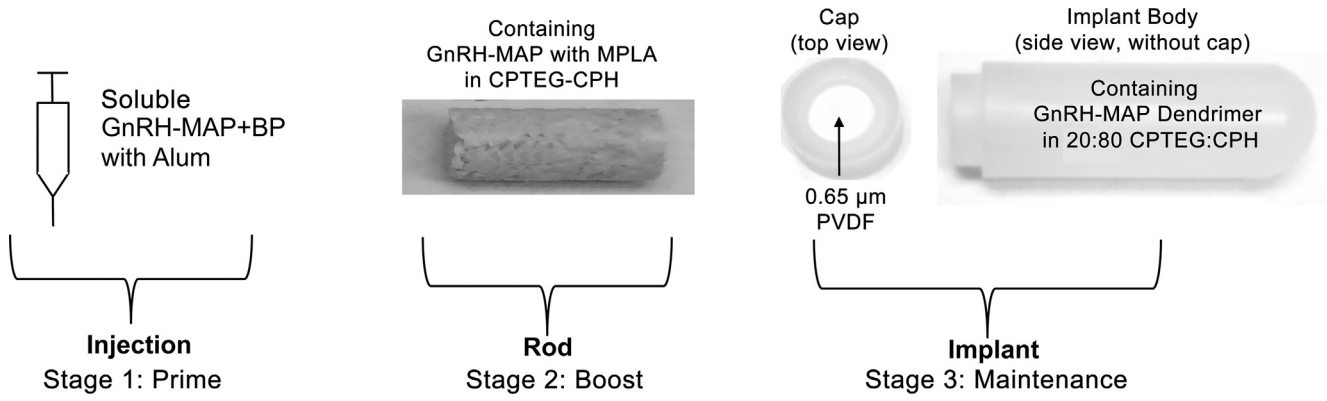
- [1] Kipper MJ, Narasimhan B. Molecular description of erosion phenomena in biodegradable polymers. *Macromolecules* 2005;38:1989–99.
- [2] Wallace DG, Rosenblatt J. Collagen gel systems for sustained delivery and tissue engineering. *Adv Drug Deliv Rev* 2003;55:1631–49.

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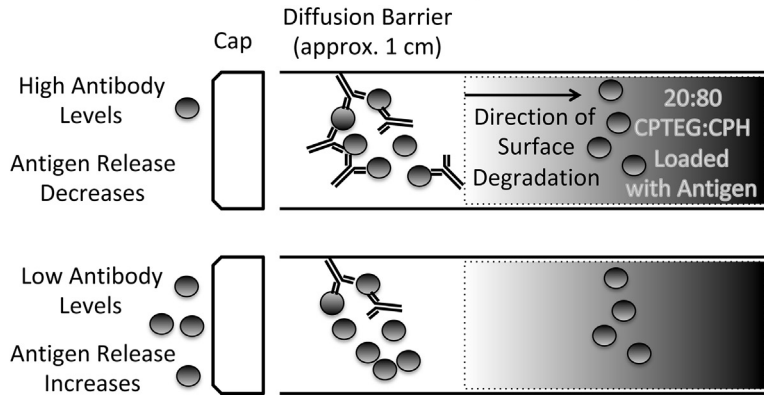
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Schematic of Theoretical Regulation of Antigen Release (Not to Scale)



Size Representation

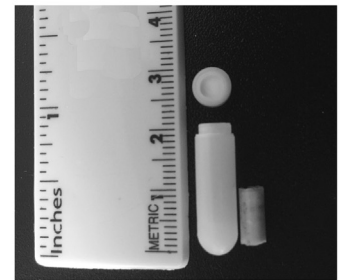


Fig. 1. Schematic of 3 stage single injection vaccine delivery device (top) with soluble priming dose, polyanhydride (PA) depot boosting dose, and implant for maintenance of immunity. The lower left schematic illustrates the theoretical passive immunoregulation of vaccine release from the implant. The lower right is an image of the implant with the PA depot that will be placed within.