## Overview of Part VII

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- **Bacterial vector**
- **Electroporation**
- **Microneedles**
- **Dry Powder**
- **In silico**

**Key Concepts**

- **Nasal associated lymphoid tissue**
- **Nasal vaccine technology**
- **Spray dried and spray freeze dried powders**
- **Lactococcus lactis and Lactobacillus spp.**
- **Lactobacillus plantarum**
- **Safe and effective plague vaccine**
- **The inflammatory response into the muscle**
- **The adaptive immune response into the muscle**
- **Muscle cells as non-professional APC**
In addition to the appropriate adjuvant, the delivery technology is another key element for vaccine development. The current intense research activity in this area will be presented in the following chapters. Pain-free and needle-less safe devices are the upcoming alternatives to conventional multiple injections. Moreover, new vaccines are designed to elicit a CTL or a mucosal response. Unlike most of the conventional vaccines, such modern vaccines require the recruitment of cellular effector mechanisms and therefore necessitate new routes of administration, combined with new adjuvants (see Part VI). New delivery technologies should also meet the need for thermostable vaccines with the great chance to turn the enormous cost-intensive cold chain down.

**Vaccine design.** The future of vaccinology is moving into obtaining a global picture of the various factors involved in protective immunity with the development of systems biology and bioinformatics tools capable of integrating various types of data. The prediction of epitopes remains a crucial step in the screening of pathogens protein-coding sequences before experimental confirmation of immunogenicity.

**Microneedles.** Intradermal vaccination using MN is one of the most attractive approaches for delivering an antigen to the dermal layer of the skin without using hypodermic injections, which are associated with transmission of infection and inappropriate disposal in the developing world.

**Nasal delivery.** The nasal mucosa is complex and includes important elements of the immune system. Therefore, it is an ideal route of delivery for a noninvasive vaccine delivery. Spray-dried, freeze-dried, and spray freeze-dried powders have demonstrated equivalent immunogenicity to conventional liquid formulations.

**Nanotechnology and delivery.** Nano-vectors bear the advantage of being similar to a pathogen in terms of size; thus, they are efficiently recognized by antigen-presenting cells of skilled immune system. ISCOMS are characterized by a cage-like structure that incorporates the antigen. They consist of lipids and Quil A, the active component of the saponin derived from the plant *Quillaja saponaria* that has adjuvant activity. PADRE-PAMAM dendrimer nano-vaccine delivery may fulfill some of the major challenges facing robust protective vaccines: it provides high transfection efficiency, proper targeting to the APCs, and an adjuvant effect.

**Bacterial vectored vaccines.** This induction of mucosal immunity through vaccination is a rather difficult task. Lactic acid bacteria have Generally Recognized As Safe (GRAS) status and have been developed in the past decade as potent adjuvants for mucosal delivery of vaccine antigens. Both *Lactococcus lactis* and *Lactobacillus spp.* have been used.

**Electroporation.** Application of an external electric field to a single cell, to cell suspensions, or to biological tissue generates a change in the cell transmembrane potential, resulting in changes to the membrane structure that render the membrane permeable to otherwise non-permeate molecules, a phenomenon termed electroporation. Electroporation technology is based on pulse generators that use different applicator electrodes, e.g., matrix of needles or plates to deliver suitable electric pulses to the target tissues.

**The Classical i.m. immunization.** Muscle cells are able to actively participate in the induction of immunity and to behave as nonprofessional APC.
Muscle cells express receptors for cytokines and PAMPs that enable them to respond to an inflammatory *milieu*, by secreting cytokines and chemokines and expressing adhesion molecules. Some membrane proteins necessary to the APC function, like class I and class II MHC molecules and costimulatory molecules, have been observed in several experimental systems.