

## 20 years of lipid nanoparticles (SLN & NLC): present state of development & industrial applications

### ABSTRACT

In 1990, the lipid nanoparticles were invented in the laboratories, the first patent filings took place in 1991. The lipid nanoparticles were developed as alternative to traditional carriers such as polymeric nanoparticles and liposomes. After 20 years of lipid nanoparticles, the present state of development is reviewed - academic progress but also the development state of pharmaceutical products for the benefit of patients. Meanwhile many research groups are active worldwide, their results are reviewed which cover many different administration routes: dermal and mucosal, oral, intravenous/ parenteral, pulmonary but also ocular. The lipid nanoparticles are also used for peptide/protein delivery, in gene therapy and various miscellaneous applications (e.g. vaccines). The questions of large scale production ability, accepted regulatory status of excipients, and - important for the public perception - lack of nanotoxicity are discussed, important pre-requisites for the use of each nanocarrier in products. Identical to the liposomes, the lipid nanoparticles entered first the cosmetic market, product examples are presented. Presently the pharmaceutical product development focuses on products for unmet needs and on niche products with lower development costs (e.g. ocular delivery), which can be realized also by smaller companies. A pharmaceutical perspective for the future is given, but also outlined the opportunities for non-pharmaceutical use, e.g. in nutraceuticals.

**Keyword:** Lipid nanoparticles; SLN; NLC; Solid lipid nanoparticles; Nanostructured lipid carriers; Drug delivery; Cosmetics; Nutraceuticals; Review; Lab scale production