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Preface

The fundamental technological advances in the last decades significantly affected all areas of the pharmaceutical sciences. New horizons have been opened and scientists use more and more sophisticated methods to develop and manufacture innovative dosage forms. This trend is likely to be continued in the future and crucial current frontiers can be expected to be overcome. The aim of this special issue is to describe some of the most promising research areas from the view point of younger scientists. The current state of the art in the respective fields is summarized and an outlook into the potential future developments provided. No effort was made to give a *complete* overview on the very broad spectrum of novel techniques and strategies. This is obviously not possible in this frame. The reader is intended to get an idea of what might be feasible in 10 or 20 years from now in specific domains of pharmaceutical technology. Fourteen research areas are addressed, covering experimental and theoretical techniques as well as novel drug delivery systems, including devices designed for particularly challenging drugs, e.g. vaccines.

The first two contributions address *innovative analytical techniques* allowing for a better characterization of pharmaceutical dosage forms in vitro as well as in vivo. This knowledge is crucial for a better understanding of how the systems work and can significantly facilitate device optimization. Various examples for practical applications are given and discussed. The subsequent article focuses on the use of *supercritical fluids* in the pharmaceutical field. This includes particle and crystal engineering, coating, formulation of biotechnological compounds, solvent removal and many more. Furthermore, an outlook into the possibilities *molecular imprinting* might offer in the future is provided. The idea is to use the "macromolecular memory" of polymeric networks to recognize specific ions, small and moderate molecular weight molecules, proteins, viruses, DNA or even cells.

Very often neglected, but of fundamental importance for oral drug administration are the *physiological and pathophysiological conditions in the gastro intestinal tract*. One of the contributions focuses on the effects of the fluid volume and composition, transit times, motility, type and concentration of bacteria, pH, food, gender, age and the disease state on the performance of the dosage forms. The significance of inter- and intra-individual variability is pointed out and various examples are discussed. In addition, novel *microscale devices for transdermal delivery* are addressed. They allow overcoming the current disadvantages of hypodermic needles for drug administration, including accidental needle-sticks, pain and needle phobia. Innovative liquid injectors, powder injectors and microneedles are described and their mechanisms of action, the importance of design parameters, various applications and challenges are discussed.

The lack of appropriate delivery systems for *oligonucleotides and siRNA* is one of the remaining major bottlenecks for an efficient treatment with this type of highly potent and promising drugs. Due to the advances in biotechnology, the latter can nowadays be produced at reasonable costs and in sufficient quantities. However, it is a major challenge to assure that these substances reach their target sites in an active form. Considerable progress has been made using novel polymeric nanocarriers, but crucial hurdles still remain. These aspects are detailed in one of the contributions together with the potential of oral, ocular and transdermal administration of this type of drugs. Furthermore, an overview on the current state of the art of *drug targeting to a specific organ* (the kidney) is given and recent results on novel kinase inhibitor-lysozyme conjugates presented. In vitro and in vivo efficiencies are discussed and a future outlook into the potential of this type of targeted drug delivery systems is given. Also, novel strategies allowing for drug *targeting to the supporting cells in tumor tissue* are presented. Tumor growth and metastasis appear to be facilitated by the interactions of tumor cells with supporting cells (e.g., adaptive and innate immune cells, endothelial cells, pericytes, fibroblasts, stromal and mesenchymal cells). The potential of new liposomal drug delivery systems targeting these supporting cells is discussed and an outlook into the future is given.

New strategies for the safe and efficient *delivery of vaccines* are the topic of two contributions: One is focusing on novel immunomodulatory biomaterials, in particular those based on biodegradable polymers. The other article specifically addresses the delivery of sub-unit vaccines. The major improvements in adjuvant research are detailed, including the increased understanding of the mechanisms of adjuvant activity. Furthermore, the major advances in *controlled drug delivery for tissue engineering* are addressed and various examples presented. It is pointed out that the fine tuning of growth factor release rates plays a key role and that the delivery of multiple drugs at optimized rates can significantly help to guide cell proliferation, differentiation and migration. Another contribution focuses on the *encapsulation of hydrophobic drugs in PLA/PLGA microparticles*. The effects of key formulation parameters on the resulting device characteristics are highlighted and challenges to be addressed in the future are pointed out.

Furthermore, the recent advances in *mathematical modeling of drug release* are described, which can at least partially be attributed to the continuous progress in information technology. The in silico optimization of novel pharmaceutical dosage forms can be expected to fundamentally increase in accuracy and easiness of application in the next two decades. Analogous to other scientific disciplines, computer simulations are likely to become an integral part of future research and development in pharmaceutical tech-

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nology. Mathematical programs are likely to be routinely used to help optimizing the design of novel dosage forms.

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