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# Nucleic Acid Transfection

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*Editors*
Dr. Wolfgang Bielke
QIAGEN GmbH
Qiagen Str. 1
40724 Hilden
Germany
wolfgang.bielke@qiagen.com

Dr. Christoph Erbacher
QIAGEN GmbH
Division Corporate Research
Qiagen Str. 1
40724 Hilden
Germany
Christoph.Erbacher@qiagen.com

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# Volume Editors

Dr. Wolfgang Bielke

QIAGEN GmbH
Qiagen Str. 1
40724 Hilden
Germany
*wolfgang.bielke@qiagen.com*

Dr. Christoph Erbacher

QIAGEN GmbH
Division Corporate Research
Qiagen Str. 1
40724 Hilden
Germany
*Christoph.Erbacher@qiagen.com*

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## Aims and Scope

The series *Topics in Current Chemistry* presents critical reviews of the present and future trends in modern chemical research. The scope includes all areas of chemical science, including the interfaces with related disciplines such as biology, medicine, and materials science.

The objective of each thematic volume is to give the non-specialist reader, whether at the university or in industry, a comprehensive overview of an area where new insights of interest to a larger scientific audience are emerging.

Thus each review within the volume critically surveys one aspect of that topic and places it within the context of the volume as a whole. The most significant developments of the last 5–10 years are presented, using selected examples to illustrate the principles discussed. A description of the laboratory procedures involved is often useful to the reader. The coverage is not exhaustive in data, but rather conceptual, concentrating on the methodological thinking that will allow the non-specialist reader to understand the information presented.

Discussion of possible future research directions in the area is welcome.

Review articles for the individual volumes are invited by the volume editors.

In references *Topics in Current Chemistry* is abbreviated *Top Curr Chem* and is cited as a journal.

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# Preface

Transfection of macromolecules into various cell types or tissues, either in vitro or in vivo, has become an indispensable technique for most fields of biomedical research. Furthermore, future applications will likely lead to an increase in the importance of transfection technologies since, with the exception of using certain drugs, there is currently little alternative to transfection for gene-specific manipulation of cells. Typically, transfections are performed with various types of nucleic acids such as genetic expression constructs, siRNAs, and occasionally messenger RNAs. Although many physical and viral transfection methods have been developed for use in different applications, the majority of protocols use chemical transfection reagents.

In this volume, we have brought together articles from various experts in the chemical transfection reagent field. Topics covered include descriptions of the chemistry of chemical transfection compounds and details of the fundamental parameters that influence transfection efficiencies.

The article by *Hahn and Scanlan* gives a general overview of common transfection methods and presents a valuable entrance point to the field.

Students, but also advanced researchers, are advised to continue with the article by *Unciti-Broceta et al.*, which gives a comprehensive outline of the chemistry underlying liquid and solid synthesis of cationic lipids and dendrimers.

A summary and discussion of empirical data on relationships between cationic lipid molecular structure and transfection activity are provided by *Koynova and Tenchov* Structural features of cationic lipids are related to their interaction with biomembranes and the uptake efficiency of transfection complexes.

Several authors describe distinct classes of chemical transfection reagents. *Fischer et al.* summarize synthesis methods, features, and applications of hyperbranched polyamines as carriers for nucleic acids.

A review from *Sizovs et al.* discusses carbohydrate-based polymeric transfection reagents, turning special attention to their potential applications in preclinical models and for the treatment of diseases.

*Ewert et al.* present recent work on structural studies of cationic lipid/nucleic acid interaction, optimized for therapeutic nucleic acid delivery. Fundamental

physical and chemical parameters that influence the uptake of transfection complexes by a cell and that are important for the improvement of transfection efficiencies are discussed.

While several reviews collected in this volume describe the basic chemical composition of transfection reagent classes, *Salcher and Wagner* focus on the modification and functionalization of polymeric gene carriers to improve their transfection efficiencies for DNA or siRNA. Such modifications include the introduction of cell-specific ligands or pH-sensitive lytic residues.

An advanced, but promising example of improvement of gene delivery technologies is highlighted in the review from *Berg et al.* Photochemical internalization is described as a versatile tool to improve the release of cargo from endocytic vesicles during the course of transfection. To achieve this, cells or tissues are exposed to a photosensitizing dye together with the molecules to be delivered into the cell. After exposure to light with a suitable wavelength, ruption of endosomal membranes occurs and the contents of the vesicle are released into the cytosol. Several photosensitizers already approved for clinical studies are presented, and their applications are discussed.

Finally, *Ruthardt and Braeuchle* summarize recent findings, describing transfection pathways of non-viral gene carriers by single particle tracking approaches. This approach allows the detailed identification of potential hurdles for efficient nucleic acid delivery from a single cell viewpoint.

We, the volume editors, hope that this book will become a helpful resource for students, as well as for the advanced scientist, by providing a deeper understanding of the mechanisms and future promise of nucleic acid transfection for research and clinical applications. As of today, this exciting field is undoubtedly far from being comprehensively explored, and technological advances will provide even better transfection tools for basic and applied research as well as for the treatment of diseases.

Hilden, Germany, Summer 2010

Wolfgang Bielke
Christoph Erbacher

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