

José das Neves · Bruno Sarmento  
*Editors*

# Mucosal Delivery of Biopharmaceuticals

Biology, Challenges and Strategies

 Springer

## Mucosal Delivery of Biopharmaceuticals

José das Neves • Bruno Sarmento  
Editors

# Mucosal Delivery of Biopharmaceuticals

Biology, Challenges and Strategies

 Springer

*Editors*

José das Neves  
IINFACTS – Instituto de Investigação e Formação  
Avançada em Ciências e Tecnologias da Saúde  
Instituto Superior de Ciências da  
Saúde-Norte, CESPU  
Gandra, Portugal

Bruno Sarmiento  
NEWTherapies Group  
INEB – Instituto de Engenharia  
Biomédica  
Porto, Portugal

ISBN 978-1-4614-9523-9      ISBN 978-1-4614-9524-6 (eBook)  
DOI 10.1007/978-1-4614-9524-6  
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2013958086

© Springer Science+Business Media New York 2014

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media ([www.springer.com](http://www.springer.com))

# Contents

## Part I Biology of Mucosal Sites

- 1 **Concepts in Mucosal Immunity and Mucosal Vaccines** . . . . . 3  
Simona Gallorini, Derek T. O'Hagan and Barbara C. Baudner
- 2 **Mucoadhesion and Characterization of Mucoadhesive Properties** . . . . 35  
Tao Yu, Gavin P. Andrews and David S. Jones
- 3 **Mucus as a Barrier for Biopharmaceuticals and Drug Delivery Systems** . . . . . 59  
Hongbo Zhang, Mohammed-Ali Shahbazi, Patrick V. Almeida and Hélder A. Santos
- 4 **Epithelial Permeation and Absorption Mechanisms of Biopharmaceuticals** . . . . . 99  
Hanne Mørck Nielsen

## Part II Delivery Strategies for Specific Mucosal Sites

- 5 **Oral Delivery of Biopharmaceuticals** . . . . . 125  
Catarina Oliveira Silva, Bruno Sarmento and Catarina Pinto Reis
- 6 **Buccal Delivery of Biopharmaceuticals: Vaccines and Allergens** . . . . 149  
Sevda Şenel, Merve Cansız and Michael J. Rathbone
- 7 **Pulmonary Delivery of Biopharmaceuticals** . . . . . 169  
Fernanda Andrade, Catarina Moura and Bruno Sarmento
- 8 **Nasal Delivery of Biopharmaceuticals** . . . . . 197  
Eiji Yuba and Kenji Kono
- 9 **Ocular Delivery of Biopharmaceuticals** . . . . . 221  
Holly Lorentz and Heather Sheardown

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.