

SpringerBriefs in Applied Sciences and Technology

Nanotheranostics

Series editors

Subramanian Tamil Selvan, Singapore, Singapore

Karthikeyan Narayanan, Singapore, Singapore

Padmanabhan Parasuraman, Singapore, Singapore

Paulmurugan Ramasamy, Palo Alto, USA

More information about this series at <http://www.springer.com/series/13040>

Piyush Kumar · Rohit Srivastava

Nanomedicine for Cancer Therapy

From Chemotherapeutic
to Hyperthermia-Based Therapy

 Springer

Piyush Kumar
Indian Institute of Technology Bombay
Mumbai
India

Rohit Srivastava
Department of Biosciences
and Bioengineering
Indian Institute of Technology Bombay
Mumbai
India

ISSN 2191-530X
SpringerBriefs in Applied Sciences and Technology
ISSN 2197-6740
Nanotheranostics
ISBN 978-3-319-45825-0
DOI 10.1007/978-3-319-45826-7

ISSN 2191-5318 (electronic)
ISSN 2197-6759 (electronic)
ISBN 978-3-319-45826-7 (eBook)

Library of Congress Control Number: 2016955424

© The Author(s) 2017

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.

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.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The aim of this book is to provide an overview of cancer therapies from conventional to nanomedicine based modern-day therapy. The initial part of the book discussed the conventional therapy and multiple drug resistance mechanisms. The conventional treatments have several limitations like nonspecific delivery, toxicity stability and multiple drug resistance by cancer cells. Among all, multiple drug resistance is a major concern for drug delivery and therapy for cancer. To overcome this, nanomedicine or drug delivery through small carrier known as nanoparticles based therapy came into existence. Owing to the small size and easy surface modification for targeting, suitability for carry both hydrophobic and hydrophilic drug, biocompatible and ease in clearance through the physiological system, nanomedicine has gained worldwide attention of researchers and pharmaceutical industries as an efficient carrier for targeted drug delivery and cancer therapy. The global market for nanomedicine was \$50.1 billion in 2011 and is expected to grow \$96.9 billion by the end of 2016 at the rate of annual growth of 14.1 % as per BCC report 2012. The tremendous potential of nanomedicine has inspired us to write this book to brief all the advancement made in this field in a concise form for an easy understanding. In the next part of the book, we have discussed the different types of nanoparticles and their targeting to the cancer cells followed by the role of nanomedicine in modern-day therapies such magnetic hyperthermia, photothermal therapy, photodynamic therapy and ultrasound based therapy and their potential and pitfalls. The book would provide an insight into recent advancement made in the field of cancer theranostic and monitoring and control of image-guided therapy. Finally, we have discussed the nanomedicine available in the market or clinical trial, challenges and future perspectives of the nanomedicine in effective diagnostics and therapy for cancer.

We hope that this small book would be helpful to graduate students and researchers working in the field of biophotonics, pharmaceuticals, applied science and engineering, and nanomedicine for targeted drug delivery and cancer therapy.

We are thankful to Indian Institute of Technology Bombay (IIT Bombay) for providing us the resources for writing this book. We would like to give our special thanks to Dr. Mayra Castro (Springer, Applied Science Germany) for her support and the opportunity to contribute this manuscript. We are also thankful to Mr. Atul Kumar Singh, Mr. Dharmendra Kumar Rai, and Dr. Hemant Kumar Singh, for their continuous support and motivation. Lastly, we would like to express gratitude to our family who always stood by us.

Mumbai, India

Piyush Kumar
Rohit Srivastava

Contents

Nanomedicine for Cancer Therapy	1
1 Introduction	1
2 Conventional Therapy for Breast Cancer	2
2.1 Limitation of Conventional Therapy	2
3 Multiple Drug Resistance (MDR)	3
3.1 Drug Efflux and Decrease in Drug Uptake	3
3.2 Alteration in Drug Target (Topoisomerase II)	5
3.3 Change in Detoxifying Enzyme Such Glutathione S-Transferase and Cytochrome P450	5
3.4 Increase in DNA Repair	5
3.5 Inhibition of Apoptosis by Disruption of Cell Signalling	5
3.6 Therapy with Multiple Drug Delivery	6
4 Application of Nanoparticles in Cancer	10
4.1 Types of Carriers (NPs) and Its Role in Nanomedicine for Cancer Therapy	10
5 Targeting or Delivery of NPs to the Cancer Cells	18
5.1 Passive Targeting	18
5.2 Active Targeting or Ligand-Mediated Targeting	19
6 Role of Nanomedicine in Modern Day Cancer Therapy	22
6.1 Gene Therapy	22
6.2 Photodynamic Therapy	24
6.3 Drug Resistance and Heat	29
6.4 Therapy Based Thermal Ablation and Hyperthermia	29
6.5 Nanoparticles Based Hyperthermia	35
6.6 Nanoparticles Based Magnetic Hyperthermia	36
6.7 Nano Radiofrequency Hyperthermia: NRFH	37
6.8 Photothermal Therapy (PTT) with Nanoparticles Formulation	38
6.9 Nano High Intensity Focussed Ultrasound Hyperthermia (NHIFU)	45

7	Combinatorial Therapy with Hyperthermia	47
7.1	Hyperthermia and Radiation	47
7.2	Hyperthermia and Drugs.	47
7.3	Hyperthermia with Photosensitization	51
8	Clinical Trials, Success, and Challenges	51
9	Conclusion	56
10	Challenges.	56
11	Prospective	57
	References	58