

Nanotechnology in the Life Sciences

Muthupandian Saravanan
Hamed Barabadi *Editors*

Cancer Nanotheranostics

Volume 2

 Springer

Editors

Muthupandian Saravanan
AMR and Nanomedicine Lab
Department of Pharmacology
Saveetha Dental College
Saveetha Institute of Medical and
Technical Sciences (SIMATS)
Chennai, India

Hamed Barabadi
Department of Pharmaceutical
Biotechnology, School of Pharmacy
Shahid Beheshti University of
Medical Science
Tehran, Iran

ISSN 2523-8027 ISSN 2523-8035 (electronic)
Nanotechnology in the Life Sciences
ISBN 978-3-030-76262-9 ISBN 978-3-030-76263-6 (eBook)
<https://doi.org/10.1007/978-3-030-76263-6>

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Switzerland AG 2021

This work is subject to copyright. All rights are solely and exclusively licensed 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, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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

Toxicity of Metallic Nanoparticles	233
In vitro Toxicity Studies of Gold Nanoparticles	233
Toxicity Effects of TiO ₂ Nanoparticles	233
In vitro Toxicity Studies of TiO ₂	233
In vivo Toxicity Studies of TiO ₂	233
Regulation Perspectives of Nanomaterial Toxicity	241
Definition and Regulation Concerns for the Nanomaterial's Characterizations	241
The Regulation Challenge for the Nanomaterials with Respect to the Pharmaceutical Context	243
Nanotoxicology and Biocompatibility	244
In vitro Assessment Methods of Nanotoxicology	245
In vivo Assessment Methods of Nanotoxicology	245
General Evaluation Methods of Nanotoxicology	246
Conclusion and Future Perspectives	247
References	248
10 Nanoerythroosome-Biohybrid Microswimmers for Cancer Theranostics Cargo Delivery	261
<i>Sree Gayathri Subbaraju, Usha Chockaiyan, Sakthieaswari Pandi, Aarthi Kannan, and Muthupandian Saravanan</i>	
Introduction	261
Insight on Microswimmers Used for Anticancer Drug Cargo	262
Characterization and Design of a Biohybrid Microswimmer for Cancer Nanotheranostics	265
Functionalization of Micro-/Nanoswimmers with Different Bioreceptors Toward Targeting Tumor Cells	266
Lipid Insertion	266
Biotin-Avidin Bridges	267
EDC/NHS Coupling	267
Antibody/Ligand-Receptor Conjugation	267
Passive Adsorption (Hitchhiking)	268
System Integration and Propelled Navigation of Microswimmers to Promote Cancer Cell Targeting	268
Propelled Ultrasound Nanoswimmers Used for Identification of miRNA in Intact Tumor Cells	269
Steered Segregation of Circulating Cancer Cells for Perception	269
Enhanced Intracellular Cancerous Cargo Delivery By Powered Cell Membrane Penetration	270
Insight on Cancer Drug Delivery Erythrocyte-Based Nanomedicine	271
Construction of Nanoerythroosome Employed By Cell Extrusion Method	271
Morphological and Physiochemical Characterization of Nanoerythrocytes	272

Mobility Assessment of Nanoerythroosome-Functionalized Biohybrid Microswimmers	273
Surface Functionalization of Erythrocyte-Based Nanomedicine for Improved Drug Delivery in Cancer Nanotherapy	274
Shape-Changing Nano- and Micromotors for Cancer Therapy	275
Evaluation of Stability Profiles of Erythroosomes and In vitro Release Studies	276
Optimization of Drug Dosage in Nanoerythroosomes (NERs)	277
Nano-/Microswimmers: Toward Clinical Translation	277
Biohybrid Microswimmers as Cargo Delivery Agents	278
Future Perspectives	279
References	279
11 Role of Artificial Intelligence in Cancer Nanotheranostics	285
Usha Chockaiyan, Abirami Sitharanjithan, Kiruthika Lakshmi Parameswaran, and Meenakshi Selvaraj	
Introduction	285
Application of AI in Medical Imaging	287
Computational Analysis of Multiplex Nanosensors for Differentiating Wild Type and Cancerous Gene	287
Computational Analysis in Nanopore Sequencing Using Artificial Neural Networks	290
Role of Artificial Neural Networks in Nanoparticle Biosynthesis	290
Optimizing Drug Combinations Using AI-Based Tools	292
Utilization of Machine Learning Algorithms in Nanotheranostic Formulation to Predict Encapsulation Efficiency	293
Prediction of Personalized Drug Potency Using Computational Tools	294
Relating Drug Dosage, Biodistribution Profiles, and Therapeutic Efficacy of Nanoparticles	294
Rationalization of Nanomedicine Interaction with Membrane Receptors	295
Contribution of Artificial Neural Networks in Survival Prediction of Cancer	296
Predicting Potential Toxicity of Nanoparticles Using Computational Analysis	297
Challenges in Clinical Implementation and Future Prospects	298
References	299
12 Limitations of Current Cancer Theranostics	305
Akshada Mhaske, Sayali Dighe, Shruti Ghosalkar, Vidhi Tanna, Padmini Ravikumar, and Sujata P. Sawarkar	
Introduction	305
Current Nanotheranostic Platforms for Cancer	306
Gold Nanoparticle (AUNPs)	307
Magnetic Nanoparticle (MNP)	307

Chapter 10

Nanoerythroosome-Biohybrid Microswimmers for Cancer Theranostics Cargo Delivery



Sree Gayathri Subbaraju, Usha Chockaiyan, Sakthiaswari Pandi,
Aarthy Kannan, and Muthupandian Saravanan

Introduction

Cancer causes about ten million deaths in 2018, and globally it is the second leading cause of cardiovascular disease. Malignant tumor was invigorated by the alteration of precancerous lesion which develops cancer as multiplex processes. Cancerous cells multiply and grow to other organs in the body, called metastases. For the survival of patients and to reduce the medication cost, it requires earlier observation of cancer and treatment (WHO, 2018). In spite of the notable developments in cancer treatment, particular side effects of chemotherapy and radiotherapy have yet to be discovered (Misra et al., 2010). Based on this matter, scientists put enormous results to evolve new nanomedication at the molecular level to treat cancer (Wu et al., 2015a; Zhang et al., 2019). Compared to free drugs, nanomedicines show high delivery efficiency, efficient retention time, lesser side effects, and prolonged circulation time (Gandhali, 2016). So, this encourages research related to nanoparticles, which would help to discover abnormalities or as carriers to transport drugs to the desired cell or as therapeutic means (Bharali et al., 2009). The concentration of

S. G. Subbaraju (✉)

Department of Microbiology, The Madura College, Madurai, Tamil Nadu, India

U. Chockaiyan

Department of Biotechnology, Lady Doak College, Madurai, Tamil Nadu, India

S. Pandi

Department of Botany and Microbiology, Lady Doak College, Madurai, Tamil Nadu, India

A. Kannan

Narayana e-Techno School, Madurai, Tamil Nadu, India

M. Saravanan

AMR and Nanomedicine Lab, Department of Pharmacology, Saveetha Dental College,
Saveetha Institute of Medical and Technical Sciences (SIMATS), Tamil Nadu, India