University of Groningen

Pre-clinical Development of Nanoparticles and Nanogels for Drug and Gene Delivery to Glioblastoma

Zhang, Huaiying

DOI:
[10.33612/diss.193920444](https://doi.org/10.33612/diss.193920444)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2021

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Zhang, H. (2021). *Pre-clinical Development of Nanoparticles and Nanogels for Drug and Gene Delivery to Glioblastoma*. [Thesis fully internal (DIV), University of Groningen]. University of Groningen.
<https://doi.org/10.33612/diss.193920444>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Pre-clinical Development of Nanoparticles and Nanogels for Drug and Gene Delivery to Glioblastoma

Huaiying Zhang

Pre-clinical development of nanoparticles and nanogels for drug and gene delivery to glioblastoma

University Medical Center Groningen, University of Groningen
Groningen, The Netherlands

The research presented in this thesis was performed at the Department of Biomedical Engineering, University Medical Center Groningen, University of Groningen. This research was supported by China Scholarship Council and de Cock-Hadders Stichting.

Cover design: Huaiying Zhang

Lay-out: Huaiying Zhang

Printing: PrintSupport4U

Copyright © 2021 by Huaiying Zhang

ISBN: 978-94-92597-89-2

university of
 groningen

Pre-clinical development of nanoparticles and nanogels for drug and gene delivery to glioblastoma

PhD thesis

to obtain the degree of PhD at the
University of Groningen
on the authority of the
Rector Magnificus Prof. C. Wijmenga
and in accordance with
the decision by the College of Deans.

This thesis will be defended in public on
Monday 20 December 2021 at 16.15 hours

by

Huaiying Zhang

born on 7 July 1991
in Sichuan, China

Supervisors

Dr. I.S. Zuhorn

Dr. P. van Rijn

Assessment Committee

Prof. dr. M.A.T.M. van Vugt

Prof. dr. A. Salvati

Prof. dr. T. Lammers

To my family

Paranimfen:

Ke Ren

Thea Vedelaar

Contents

Chapter 1	9
General introduction and aim of the thesis	
Chapter 2	35
Development of curcumin-loaded zein nanoparticles for transport across the blood-brain barrier and inhibition of glioblastoma cell growth	
Chapter 3	63
Curcumin-loaded zein nanoparticles potentiate temozolomide-induced cell death in GBM cells and patient-derived GBM neurospheres	
Chapter 4	87
Aliphatic quaternary ammonium functionalized nanogels for gene delivery	
Chapter 5	113
Summary and future perspectives	
Appendix	119
Nederlandse Samenvatting	121
Acknowledgements	125
Curriculum Vitae	128