



Universiteit
Leiden
The Netherlands

Mesoporous silica nanoparticle-based protein delivery systems for biomedical applications

Tu, J.

Citation

Tu, J. (2016, December 21). *Mesoporous silica nanoparticle-based protein delivery systems for biomedical applications*. Retrieved from <https://hdl.handle.net/1887/45230>

Version: Not Applicable (or Unknown)

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/45230>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/45230> holds various files of this Leiden University dissertation

Author: Jing Tu

Title: Mesoporous silica nanoparticle-based protein delivery systems for biomedical applications

Issue Date: 2016-12-21

**Mesoporous Silica Nanoparticle-Based Protein
Delivery Systems for Biomedical Applications**

JING TU

Doctoral Thesis, Leiden University, 2016

Cover design: Jing Tu

Printed by GVO drukkers & vormgevers B.V. Ede

ISBN: 978-94-6332-119-8

Mesoporous Silica Nanoparticle-based protein delivery systems for biomedical applications

Proefschrift

ter verkrijging van

de graad van Doctor aan de Universiteit Leiden,

op gezag van Rector Magnificus Prof. mr. C.J.J.M. Stolker,

volgens het besluit van het College voor Promoties

te verdedigen op woensdag 21 december 2016

klokke 10:00 uur

door

涂晶

Jing Tu

Geboren op 11 Oktober te Wuhan, China in 1985

Promotiecomissie

Promotor: Prof. dr. A. Kros

Overige leden:

Prof. dr. J. Brouwer (voorzitter)

Prof. dr. J. Bouwstra (secretaris)

Prof. dr. J.I. Zink¹

Dr. S. Bonnet

Dr. C.F. van Nostrum²

1 Dept. Chemistry & Biochemistry, UCLA, USA

2 Dept. Pharmaceutics, Utrecht University, the Netherlands

To my family

Table of Contents

Chapter I

General Introduction	9
----------------------	---

Chapter II

Mesoporous Silica Nanoparticles with Large Pores for the Encapsulation and Release of Proteins	27
--	----

Chapter III

Mesoporous Silica Nanoparticle-Coated Microneedles for Intradermal Delivery of Ovalbumin	49
--	----

Chapter IV

Membrane Fusion Mediated Intracellular Delivery of Lipid Bilayer Coated Mesoporous Silica Nanoparticles	71
---	----

Chapter V

Lipid Bilayer-Coated Mesoporous Silica Nanoparticles Carrying Bovine Hemoglobin as an Erythrocyte Mimic	97
---	----

Chapter VI

Estimation of Single Mesoporous Silica Nanoparticle's Weight	121
--	-----

Chapter VII

Summary and Perspectives	129
--------------------------	-----

Curriculum vitae	141
-------------------------	-----

List of publications	142
-----------------------------	-----

