

CONTENTS

LIST OF SYMBOLS AND ABBREVIATIONS	ix
LIST OF PUBLICATIONS	xv
ABSTRACT	xix
ZUSAMMENFASSUNG	xx
I PREFACE	1
1 INTRODUCTION	3
2 THEORETICAL BACKGROUND ON BIOCOMPATIBLE Li_0 IRON- PLATINUM NANODEVICES	13
2.1 Swimming at low Reynolds numbers	13
2.1.1 Navier-Stokes equations	13
2.1.2 Life at low Reynolds numbers	16
2.1.3 Magnetically actuated helical micro- and nanopropellers	18
2.1.4 Brownian motion	21
2.1.5 Self-phoresis	22
2.2 Glancing angle deposition	23
2.3 Iron-platinum ferromagnetism	25
2.4 SQUID magnetometry	29
2.5 Mass transport pathways across the cell membrane	31
2.5.1 Active and passive cell membrane penetration	32
2.5.2 Phagocytosis	34
2.5.3 Clathrin-dependent and clathrin-independent endocytosis	35
2.5.4 Chemical and physical transfection pathways	36
3 THEORETICAL BACKGROUND ON BIODEGRADABLE PROPELLERS FOR GENE THERAPY	39
3.1 Biomedical devices based on magnesium and zinc	39
3.2 Viral gene therapy	41
4 THEORETICAL BACKGROUND ON M13 BACTERIOPHAGE SELF-ASSEMBLY	43
4.1 M13 bacteriophages	43
4.2 M13 bacteriophages for enzyme catalysis	46
4.3 Self-assembly and DNA origami	49
4.3.1 Thermodynamics of self-assembly	49
4.3.2 DNA structure and folding	50
4.3.3 Programmable self-assembly: DNA Origami	52

II	BIOCOMPATIBLE L1 ₀ IRON-PLATINUM NANODEVICES	55
5	IRON-PLATINUM NANOPROPELLERS AND CELL TRANSFECTION	57
	SUPPORTING INFORMATION - IRON-PLATINUM NANOPROPELLERS AND CELL TRANSFECTION	69
6	LIGHT- AND MAGNETICALLY ACTUATED IRON-PLATINUM MI- CROSWIMMERS	81
III	BIODEGRADABLE PROPELLERS FOR GENE THERAPY	95
7	BIODEGRADABLE MAGNESIUM-ZINC NANOPROPELLERS FOR GENE THERAPY	97
7.1	Introduction	99
7.2	Discussion and Results	100
7.3	Methods	111
7.3.1	Iron-platinum cups - Interfacial transfer of polystyrene beads and FePt coating	111
7.3.2	Fabrication and characterization of Mg-Zn-based propellers . .	112
7.3.3	Cell culture	112
7.3.4	Transfection	113
7.3.5	MTS Viability Assay	113
7.3.6	Crystal violet staining	114
7.3.7	Caspase 3/7 activity assay	114
IV	M13 BACTERIOPHAGE SELF-ASSEMBLY	115
8	M13 BACTERIOPHAGE NANONETS FOR ENZYME CATALYSIS	117
	SUPPORTING INFORMATION - M13 BACTERIOPHAGE NANONETS FOR EN- ZYME CATALYSIS	129
V	CONCLUSION	139
9	CONCLUSION	141
	ACKNOWLEDGEMENTS	151
	BIBLIOGRAPHY	153