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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>

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**Author:** Jing Tu

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

**Issue Date:** 2016-12-21

# Stellingen

Behorende bij het proefschrift

## Mesoporous Silica Nanoparticle-Based Protein Delivery System for Biomedical Applications

Jing Tu, Leiden, 2016

1. Proteins used as a therapeutic are usually characterized by their short plasma half-life, high elimination rate, limited ability to cross cell membranes, and poor bioavailability through intestinal administration. **Chapter 1**, this thesis.
2. It was shown that phospholipid membranes are able to assemble into different structures upon contact with a hydrophilic surface, involving vesicle adsorption, rupture and spreading into planar membranes. **Chapter 1**, this thesis.
3. Small (< 200 nm) MSNs with ordered large pores (> 5 nm), capable of encapsulating therapeutic small molecules suitable for delivery applications *in vivo*, are rare however. **Chapter 2**, this thesis.
4. Encapsulating proteins in MSNs is still challenging however, and only a few publications concerning the design of MSNs with a morphology that enables the effective encapsulation of a broad range of proteins are available. **Chapter 2**, this thesis.
5. Most of the current vaccines are delivered by intramuscular or subcutaneous injection, but the inherent limitations are obvious, such as the risk of the needle-related disease induced by reusing needles and syringes, the needle fear by children and patients, and the need for maintaining a proper cold chain during storage and transport. **Chapter 3**, this thesis.
6. Protein delivery into the cytosol of cells is a challenging topic in the field of nanomedicine, because cellular uptake and endosomal escape are typically inefficient, hampering clinical applications. **Chapter 4**, this thesis.
7. Mesoporous silica nanoparticles (MSNs) can be used as protein delivery carriers due to their unique properties, namely biocompatibility, chemical inertness, large surface area and controllable pore size. **Chapter 5**, this thesis.
8. In (bio)nanotechnology, individual nanoparticles are as unique as people's fingerprints, therefore it becomes imperative to find methods for the full characterization of nanoparticles. **Chapter 6**, this thesis.