POPULAR SCIENTIFIC ABSTRACT

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Engineered Nanoparticles for Delivery of Pharmaceuticals in Cancer Therapy:
Rational design for targeted and stimuli responsive delivery of biopharmaceuticals

Despite the noteworthy progress in the prevention, detection, and treatment of cancer, it is predicted that one in five men and one in six women will develop the disease during their lifespan. Thus, cancer has a tremendous impact on both public health and the economy worldwide. One of today's primary treatment methods involve the use of chemotherapeutic active pharmaceutical ingredients associated with severe and lethal side effects. Hence, there is high incitement to improve drug specificity and delivery to reduce side effects and optimize therapeutic efficiency; this has led to extensive research to find new and better active pharmaceutical ingredients and treatment methods, including the utilization of highly specific biopharmaceuticals like small interfering RNAs (siRNAs) and 'targeting' proteins, e.g., antibodies. Nevertheless, efficient and well-controlled delivery remains a significant hurdle.

Nanotechnology provides a foundation to circumvent the limitations and challenges related to small molecule active pharmaceutical ingredients and biopharmaceuticals and has led to the establishment of the nanomedicine field. Nanomedicines are carrier materials designed to improve the drug properties and enable controlled drug delivery and release, aiming to increase drug efficiency and safety; by engineering nanoparticles that can be applied to identify disease markers or deliver drugs to the site of action in the body. Nanoparticles are excellent drug carriers due to their unique properties, including their size (20 nm to 1000 nm), high drug loading capacity, ease of modification, and the possibility to utilize targeting molecules. Noble endeavors have been put into the development of new nanomedicine therapeutics. However, translation into clinical use remains close to absent; thus, such systems' full advantages are yet to be achieved. Therefore, nano-scaled drug delivery systems, based on simple and rational design, are still wanted, and continuing to explore new materials, methods, and possibilities to improve cancer therapeutics is essential.

The PhD project's goal has been to explore the next generation of generic drug delivery systems, namely, cancer treatment, based on smart nanoparticle-based drug delivery platforms, to enable efficient delivery of potent and specific therapeutics using simple formulation approaches. The project has been divided into four branches; the first branch focused on investigating new small molecule therapeutics based on Falcarinol and Falcarindiol, aiming to find a better disease cure for colorectal cancer. The project has contributed to an increased insight into the underlying mechanism of action promoting the chemopreventive and chemotherapeutic properties of Falcarinol and Falcarindiol. Moreover, the project has engineered a novel and simple nanoparticle-based delivery platform for intracellular delivery of Falcarindiol and similar compounds. The project has furthermore explored the field of precision medicine, giving rise to the other three branches. The second branch focused on developing a simple, fast, inexpensive, and versatile method for formulating antibody conjugated lipid nanoparticles, enabling targeted delivery of protected drug payloads to the intracellular compartment. The third branch focused on developing a novel nanoparticle-based delivery platform that enables combination therapy using small molecule drugs and therapeutic biopharmaceuticals. Finally, the fourth branch focused on developing a smart, fully biodegradable pH and redox responsive nanoparticle-based delivery platform for the intracellular delivery of therapeutic siRNAs.

While this PhD project has developed new potential nanoparticle-based drug delivery systems for cancer treatment applications, the developed systems may also find applications as delivery platforms to treat various diseases with an underlying intracellular origin. The project has contributed to developing better disease cures, including the potential further implementation of highly specific and potent biopharmaceuticals.