Therapeutic Nanoparticles as Drug carriers: Mixture nanoparticles bear multiple domains

- Parenteral nano-drug application (injection): mRNA nano-complexes for immunotherapy and cancer therapy [15-18] work by cellular synthesis of the corresponding specific protein (not the antigen, but the genetic information for its production). The cells and the immune system of the patient work as biological drug amplifier.

- mRNA and synthetic pharmaceutical drugs can be applied in mixed nanoparticles bearing a material domains of drug, excipients, carrier, surface ligands. Two classes cover the main drug nanoparticle forms: polymer nanoparticles and liposomes and mRNA-drug nanoparticles. For therapeutic mRNA both classes were investigated by D-contrast SANS at the MLZ (KWS2 reactor) of the Jülich Research Centre, by SAXS at the DESY PETRA III (P12 beamline).

- Oral nano-drug application (tablets, capsules) is tested with a simulator device of the gastro-intestinal tract with SANS+DLS observation of drug nanoparticles and intermediates. The structure optimized drug-carriers shall improve the application of hydrophobic and difficult drugs (BCS-classes 2-4), food drug-interactions and side effects. A specific development was the introduction of a cholesterolemic containing medium D-contrast SANS (D-contrast SANS observes specific target and modulated by comparison). For nanoparticles, micelles, magnetic oxide, and polymer-protein particles.

- The power of D-contrast SANS is the specific detection of material domains with different hydrogen content, e.g. of drug, mRNA, lipid, polymer, protein. The mixed nanoparticles (100 nm), e.g. biodegradable PLA, polyethylene glycol, carboxydrates, intestinal lipid-nanoparticles, lipid particles, surface-proteins and optional bio-target domain are amphoteric and partly charged. Thus the internal particle structure forms sub-domains of different material and scattering power.

- The mixed nanoparticles were localized in the gastro-intestinal fluid system were studied by D-contrast SANS and by DLS. By time-resolved neutron scattering TR-SANS and EM, the specific target and modulated by comparison. For nanoparticles, micelles, magnetic oxide, and polymer-protein particles.

- Specific target Nanoparticles for therapy of cancer and other diseases were assembled from liposomes, polymers and pharmaceutical drugs or mRNA. For cell targeting proteins were bound to the surface (corona). The structure is solution by analyzing dynamic light scattering DLS and SANS combined with neutron small angle scattering SANS, SANS, metal specific X-ray scattering ASAXS. Material sub-domains in the nanomaterial drug carrier (100 nm) were localized by Deuterium-contrast variation in SANS and by ASAXS. [7, 2-4] of nanoscaled drug carriers (liposomes, solid lipid particles, micelles, magnetic oxide, and polymer-protein particles).

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- Targeting drug carriers for nanotherapy.

- Tissue and cell targeting: Intestinal, cell or tumor recognition and uptake of the drug carriers can be triggered by a surface protein or ligand (see method sub-page 17).

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