Drug-loaded Urease-powered nanomotors for the potential treatment of bladder cancer

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In recent years, enormous research efforts have been made to minimize the side effects of drugs and to increase their therapeutic efficiency in the treatment of cancer. Bladder cancer, for example, is the ninth most common cancer worldwide for which current therapies prolong patient survival, but also show high relapse rates, making it urgent to improve existing therapies. Using the catalytic reaction of enzymes that consume bioavailable fuels to propel micro- and nanoparticles (nanomotors) has expanded their potential applicability in nanomedicine and might provide a platform to overcome drug delivery challenges. Here, we present urease-powered nanomotors based on mesoporous silica nanoparticles (MSNP) loaded with clinically relevant drugs (Mitomycin, Erdafitinib) for the potential treatment of bladder cancer. The procedure of MSNP synthesis to obtain homogeneous particle size distributions and ensure proper pore opening for subsequent drug loading has been optimized. Furthermore, swarming behaviour in ionic and proteinaceous media has been tested in presence of different concentrations of urea (0 mM up to 300 mM). In addition, spectral flow cytometry as a novel tool to analyse particle delivery efficiency has been carried out with mouse bladder carcinoma cells (MB-49) after incubation (1 h, 4 h) with active (MSNP-Urease) and passive (MSNP-BSA) FITC-labelled nanoparticles at different urea concentrations. When the nanoparticles were incubated with MB-49 cells, active nanomotors showed a 3.2-fold increase of the delivery efficiency in presence of 100 mM urea compared to passive particles after only 1 h of incubation. The drug loading results, biocompatibility tests and enhanced delivery efficiency of active nanomotors to MB-49 cells may proof their potential to be used in future nanomedical applications for the treatment of bladder cancer.

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Figures

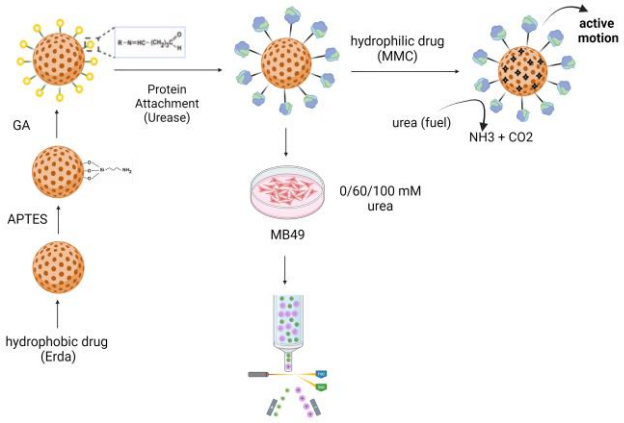

Figure 1. Graphical abstract of drug-loading strategy of Urease-nanomotors. Cell internalization experiments were carried out with non-loaded nanomotors using spectral flow cytometry to determine the delivery efficiency to MB49 cells in presence and absence of fuel.