Smart drug delivery systems for cancer therapy

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Cancer remains a global health problem and a major cause of death worldwide. Statistical analysis published by the International Agency for Research on Cancer from the World Health Organization reveals that if the estimated trends continue, the incidence of all cancer cases will raise from 12.7 million new cases in 2008 to 21.2 million by 2030 [1]. Ideal nanocarrier-based therapy, contains first a controlled mechanism for drug delivery, to minimize side effects in healthy tissues, and second has the ability to provide a controlled drug release to extend the therapeutic duration of the therapeutic treatment.

Nanocarrier based chemotherapy is one of the few nanotechnology-based medical therapies that reached the clinics, already in 1995, when the commercial anticancer drug delivery system DOXIL® was introduced in the market [2], but available systems are far from optimal selectivity and controlled release.

Our work describes a combined spectroscopy and imaging study to evaluate a smart drug delivery system for cancer therapy. In our study we used DODAX:MO (1:2) formulations with a diameter of approx. 100 nm to study the biophysical characteristics when used for trafficking paclitaxel (PTX) and doxorubicin (DOX), both widely used chemotherapeutic anti-cancer drugs.Besides established biophysical profiling techniques to determine the pharmacokinetic of drugs; fluorescence based quenching assays allow a nanoscale localization of the anticancer drugs within the 100 nm diameter liposomal formulations.

In addition to the determination of the partition coefficients and the characterization of drug effects in membrane microviscosity, we use fluorescence (lifetime) spectroscopy to obtain nanoscale information of drug binding inside of innovative lipid based nano drug delivery systems, using molecular markers that are anchored at different depths within the lipid bilayer to sense the localization of the drug via a fluorescence quenching effect. To follow the internalization of liposomes into cancer cells we perform confocal fluorescence imaging of cancer cells exposed to liposomal formulations and compare with non encapsulated anticancer drugs.

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