FRET-Based Combination Drug With Enhanced Photothermal Therapy

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The Forster resonance energy transfer (FRET) phenomenon has been widely used for biological applications. Herein, FRET mechanism is used for the first time to develop a combination therapy drug using ion exchange to treat tumors effectively. This project addresses the demand for economical and effective strategies to treat the significantly growing number of cancer cases every year. Two FRET-based combination drugs were synthesized by combining a chemotherapeutic cation, Doxorubicin Hydrochloride (DOX), and a photothermal agent anion (IR783 or IR820). DOX serves as a donor while IR dyes serve as an acceptor in the FRET-based drugs. FRET mechanism between the two ions in a combination cancer therapy enhanced overall cytotoxicity of the drug due to synergy. Spectral overlap between DOX fluorescence emission and IR783/IR820 absorption indicated FRET. The FRET efficiency was calculated to be 17% for [DOX][IR783]. The photo-physical properties of IR dyes significantly improved which consequently improved the overall cytotoxicity of the drugs. The photothermal activity of the combination drugs was investigated by measuring light to heat conversion efficiency, which exhibited significant increase compared to parent compounds. Furthermore, increase in singlet oxygen quantum yield value improved tremendously when IR dyes were converted into FRET combination drugs. The in vitro cytotoxicity experiment revealed that FRET combination drugs have lower IC50 values compared to their respective parent compounds due to enhance retention and permeation of drug due to nanoparticle formation. This method to develop cost effective nanoparticles with FRET characteristics is phenomenal and can design other drugs with enhanced therapeutic efficiency.

Awards Won:

American Chemical Society: Diploma of Recognition and $100 gift card