Nano-Enabled Encapsulation for Doxorubicin

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Conventional chemotherapy encounters significant challenges, including low tumor targeting efficacy, systemic toxicity, and limited tissue penetration. To address these issues, a novel ZnO nanoparticle system for the co-delivery of both doxorubicin and curcumin. Fabricated via the sol-gel method, coated with polysarcosine to enhance biocompatibility and immune evasion. The Doxorubicin is linked via an acid and hypoxia-reactive dihydrazone linker, for drug release in the tumor microenvironment. The system employs iRGD peptide targeting avß3 and avß5 receptors, aiming to improve treatment efficiency across a range of cancers, including breast (MDA-MB-231), pancreatic (PANC-1), lung (A549), glioblastoma (U87MG), melanoma (A375), and ovarian (SKOV3) cancers. Characterization of the nanoparticles revealed an average size of 30 ± 5 nm, polydispersity index (PDI) of 0.20, and zeta potential of -10.2 mV. These help the nanoparticle to circulate in the bloodstream long enough to reach tumors. In vitro studies demonstrated that the system induced 80% apoptosis in cancer cells, indicating strong apoptosis due to the DOX and ZnO combination. To assess the system's effectiveness, co-culture models utilize varying cancer-to-healthy cell ratios. Furthermore, reactive oxygen species (ROS) revealed a 3.5-fold increase in oxidative stress compared with free doxorubicin. Cytotoxicity results were negligible in healthy cell controls, with a setup of 100% healthy cells and 0% of cancer cells, highlighting nanoparticles' targeted capabilities with a result of treatment of 70%-75% to 88%-92% in breast cancer, chemotherapy to nanoparticles, respectively. This system is biodegradable and minimizes potential side effects, including cardiotoxicity, by incorporating curcumin as an antioxidant.

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