Targeted Breast Cancer Therapy Using Nanoparticles Modified by Tumor-Homing Peptides

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Nanoparticles (NPs) are attractive cancer drugs but cannot target cancer cells, causing side effects in cancer therapy. To tackle this challenge, I developed NPs that could kill breast cancer cells specifically without harming healthy breast cells. To synthesize such NPs, I first prepared bismuth nanocrystals that could absorb a tissue-penetrating near infrared (NIR) light to generate heat. I then coated them with a nano-shell of porous silica. I finally conjugated a breast tumor-homing peptide onto the shell, which was further loaded with doxorubicin (DOX) in the pores. To prove cancer cell targeting, I incubated fluorescently labeled NPs with breast cancer cells (MCF7, ATCC® HTB-22™) and verified their cell internalization by confocal microscopy. To demonstrate targeted therapy, I used a NIR light to irradiate NP-incubated MCF7 cells to trigger photothermal therapy in addition to DOX-induced chemotherapy. I verified cell killing by alamarBlue and LIVE/DEAD viability assay. I used normal breast cells (MCF10A, ATCC® CRL-10317™) as control cells, and employed free DOX and the NPs with the homing peptide replaced by a non-targeting peptide or polyethylene glycol as control drugs. I confirmed the synthesis of the NPs using electron microscopy and optical spectroscopy. The NPs could immediately liberate heat in response to NIR irradiation and selectively release DOX in the tumor-like acidic environment. The NPs, instead of the control drugs, could be specifically internalized in breast cancer cells, enabling them to kill the cancer cells, but not the normal cells, through both chemotherapy (by releasing DOX) and photothermal therapy (by light-triggered heating). Hence, the new NPs can be used for highly efficient targeted breast cancer therapy with minimized side effects.