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Europium-doped calcium fluoride nanoparticles coated with melanocortin stimulating hormone-4 for potential biomedical imaging

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Lanthanide-based nanomaterials have promising applications including high throughput drug screening, bio-analytical sensing, and biomedical imaging. Among many lanthanide-based nanomaterials, europium (III) ions are of particular interest in biological assays due to their long luminescent lifetimes, limited photobleaching, monochromatic emission at 614 nm, and large Stokes shifts. Compared to well-known lanthanide-doped matrices such as yttrium fluoride and lanthanum fluoride, calcium fluoride matrix has shown to have promise as an imaging agent due to their greater luminescent efficiency and high biocompatibility. This work focuses on synthesizing novel europium-based nanomaterials and functionalization of the surface of the nanoparticles with a melanocortin stimulating hormone (MSH-4) peptide targeting human cells expressing human melanocortin receptors (hMCRs). A microwave-based synthetic method was optimized to prepare europium-doped calcium fluoride nanoparticles with a controlled size distribution in the 100-120 nm range. The optimized parameters include a pH of 6, reaction time of 30 minutes at a microwave power of 100W. Control over size distribution of the nanoparticles was achieved by adjusting the initial reactant ratios. The nanoparticles were characterized by using powder X-ray diffraction (XRD), dynamic light scattering (DLS), Fourier-transform infrared spectroscopy (FTIR), luminescent spectroscopy (UV-Vis), and transmission electron microscopy (TEM). The melanocortin stimulating hormone (MSH-4) peptide was synthesized using the standard solid phase peptide synthesis method and characterized using LCMS and was determined to be 67% pure. The europium-based nanoparticles were functionalized with the MSH-4 peptide which is an agonist for hMCRs. Further research will be carried out to investigate the potential of using peptide functionalized nanoparticles for biomedical imaging.

Keywords: MSH-4, nanoparticles, biomedical imaging, peptides, lanthanides

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