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Decoration of gold nanostars with a polyamidoamine-Ru(II) complex to increase $^1\text{O}_2$ generation efficiency in Photodynamic Therapy

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Introduction

Photodynamic Therapy (PDT) is a noninvasive medical treatment consisting of ROS production with the excitation of a photosensitizing molecule (PS) using a suitable light. The excited PS undergoes intersystem crossing from the singlet to the triplet excited state, where, in Type II PDT, its energy transfers to molecular O_2 , generating the cytotoxic $^1\text{O}_2$.¹

A promising PS for PDT is Ru-phenAN, a polyamidoamine polymer bearing a Ru(II) complex, prepared and characterized by our research groups.² Ru-phenAN has been proven to produce $^1\text{O}_2$ with a good yield and to be efficiently internalized by cells. Furthermore, when irradiated, Ru-phenAN promotes endosomal escape and accumulates in the nucleus, increasing the effectiveness of its use for PDT.³

In this ongoing project, we functionalized the surface of gold nanostars (GNSs) with Ru-phenAN to test whether the metal core might increase $^1\text{O}_2$ generation through an energy transfer to the photosensitizer via Localized Surface Plasmonic Resonance (LSPR), hence increasing PDT efficacy.

Methods and Results

GNS@Ru-phenAN nanoparticles were prepared by using a layer-by-layer approach: first a layer of a negatively charged polyamidoamine was adsorbed on the GNS, then Ru-phenAN in order to increase the distance between the Ru-phenAN and the metal core. The size, z-potential and stability of the nanoparticles in water and PBS were characterized, as well as their absorption and emission spectra.

Uptake by Hela cells was then measured and compared to Ru-phenAN alone, showing a comparable internalization and emission inside the cells.

Next, the cytotoxicity and the production of reactive oxygen species (ROS) of the Ru-phenAN polymer, GNS@Ru-phenAN and the bare GNSs have been compared, both in the dark and after irradiation in the visible spectral range.

Conclusions

The results obtained so far showed an increase in $^1\text{O}_2$ production and cytotoxicity for the GNS@Ru-phenAN compared to the Ru-phenAN alone after irradiation, suggesting that adsorption onto the gold nanostars may be used to enhance Ru-phenAN efficacy in PDT.

References:

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