Photoactivated gold nanoparticles as promising agents for photothermal therapy – *in vitro* studies in biomimetic membrane systems

In the latest literature, it is become more and more popular to study the influence of gold nanoparticles (Au-NPs) on the properties of model cellular membranes using the Langmuir technique. The explanation of the mechanism of interaction of photoactivated Au-NPs with the lipid membrane is of great importance for the potential therapeutic applications of Au-NPs in photothermal therapy (PTT). Characterization of layers, formed both at the air-water and air-solid interfaces, by means of spectroscopic and microscopic methods, provides detailed information on the influence of the shape, coating of Au-NPs, and local temperature increase on the formation of lipid monolayers, their stability and phase state, the way lipids are distributed in membranes, and on the release and distribution of the heat inside the healthy and cancerous cell.

The aim of the project is to investigate changes in properties of healthy and neoplastic cellular membranes under the influence of photoactivation of functionalized Au-NPs of different shapes, hydrophobicity and the type of their coating parameters. The shapes and functionalization of Au-NPs can influence the heat distribution in different ways and increase the local temperature after selective excitation of Au-NPs with a wavelength corresponding to the localized surface plasmon resonance. The planned research will allow for a comparison of the effect of photoactivated Au-NPs on the monolayers that make up model cell membranes. The obtained results will allow us to find answers to the following questions: How does photoexcitation of Au-NPs, causing local temperature rise, affect the packing and phase behavior of biomimetic systems, which are models of cellular membranes of healthy cells and neoplastic cells? For what kind of NPs, taking into account shape and functionalization, will the optimal photothermal effect be observed and/or can they be promising agents for photomedical applications?

The project will involve a large variety of methods, including chemical synthesis, spectroscopic and microscopic investigation, and theoretical calculations. This project assumes some fundamental steps. In the first step, the procedure for the synthesis of Au-NPs of various shapes will be optimized to obtain nanorods, nanotriangles and nanostars with the desired optical properties. The Au-NPs will then be functionalized with poly(ethylene glycol) of different chain lengths to have different hydrophobicities and to be soluble in nonpolar solvents. In the next stage, using the Langmuir technique at the air-water interface, lipid monolayers will be produced corresponding to the composition of the membranes of healthy cells and neoplastic cells into which the Au-NPs excited by light will be added, with a wavelength corresponding to the excitation wavelength of Au-NPs. In the last step, the produced monolayers will be transferred to solid substrates using the Langmuir-Blodgett and/or Langmuir-Schaefer techniques, which will allow the characterization of their properties under change illumination by means of microscopic methods.

The obtained results will allow us to understand whether the photoactivation of Au-NPs causes differences (and of what kind) in the organization of cellular membranes and if it can disturb their integration, as well as support the transport of medicinal substances, and whether it can cause different (uniform or local) increase in temperature in healthy and neoplastic cellular membranes. The achievements obtained in the project will allow for the selection of the best Au-NPs (with defined shape and functionalization) that have significant potential in photomedical applications, first of all in PTT but also can have significance in dual PTT/photodynamic therapy or PTT/pharmacotherapy.