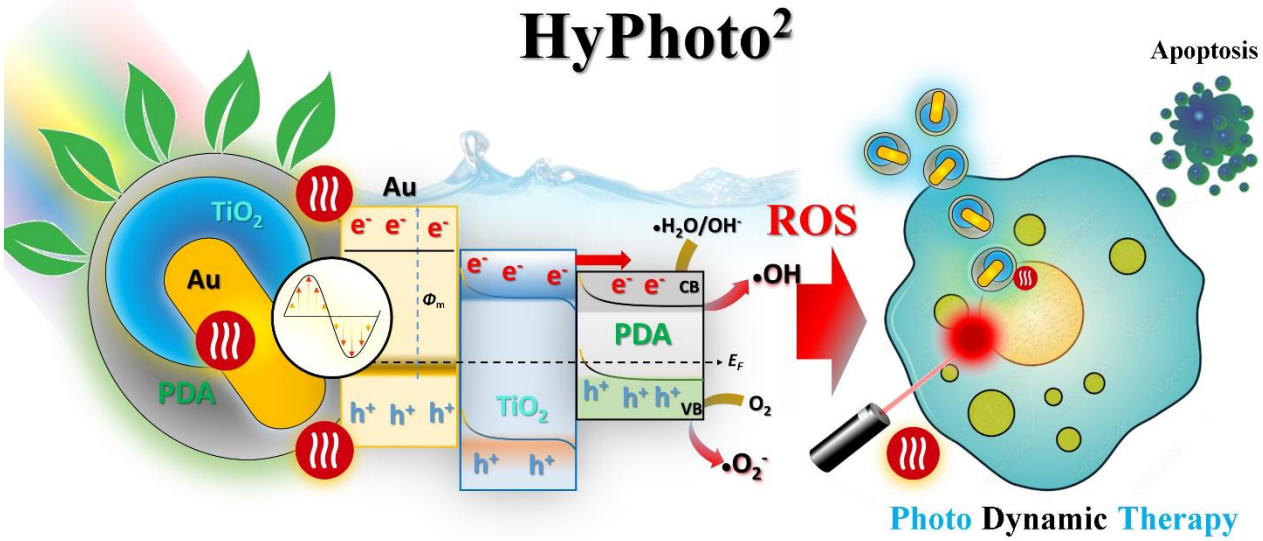
Hybrid Nanocomposites Based on Gold Nanoparticles as Promising Photoactive Materials for Combined Photothermal/Photodynamic Therapy – HyPhoto^2

The development of methods and possibilities for producing nanomaterials implies progress in the field of improvement and application of new medical procedures. Interdisciplinary research is carried out on many levels in order to find effective diagnostic and/or therapeutic methods using e.g. metallic nanoparticles. Determining the photophysical properties of nanoparticles and examining their interactions with biological material provides important information to create increasingly better drug or vaccine delivery systems and to identify the occurrence of potential side effects. The **HyPhoto^2** project proposes to conduct basic research for systems based on gold nanoparticles, which in the area of the so-called therapeutic window (above 650 nm) show plasmon resonance, associated with the interaction of light with free electrons of metallic nanostructures. The interaction of surface plasmons with the dye may affect the efficiency of photophysical processes, important from the point of view of potential applications of metal-dye hybrid systems in photomedicine. The results of the research will provide important information about the photophysical properties of the tested, functionalized nanoparticles and their hybrid nanocomposites, and will indicate the potential possibility of their use in biomedical applications.



The **HyPhoto^2** project aims to combine and improve photodynamic and photothermal therapeutic functions by preparing and testing gold nanoparticles coated with titanium dioxide and polydopamine with a chemically attached organic dye - a chlorophyll derivative with EGF protein-bioconjugates. The specific research objectives of the **HyPhoto^2** project include the synthesis and optimization of gold nanoparticles of various shapes showing plasmon resonance in the therapeutic window, functionalisation of the obtained gold nanoparticles with titanium dioxide and polydopamine, chemical functionalisation of the obtained system with chlorophyll derivatives, and biological tests using cell cultures. The project will involve a large variety of methods, including chemical synthesis, spectroscopic and microscopic investigation, and theoretical calculations.

The research planned in the **HyPhoto^2** project will make it possible to understand whether the shape of gold nanoparticles in hybrid systems with a dye causes differences (and of what kind) in singlet oxygen generation efficiency and whether it enhances the photothermal effect in healthy and cancerous cells. The achievements made in the project will allow the selection of the best system based on gold nanoparticles (with a specific shape and functionalisation), which has significant potential in photomedical applications, primarily in photothermal therapy, but can also be used in double, combined photothermal/photodynamic therapy or photothermal therapy/pharmacotherapy. The new hybrid systems produced will be tested using cell cultures to assess their properties, which determines the phototoxicity or diagnostic usefulness of the system.

As part of the **HyPhoto^2** project, we will learn how to generate singlet oxygen more efficiently and how to enhance the photothermal effect of the studied nanocomposite systems based on gold nanoparticles of various shapes with chlorophyll dyes and EGF protein-bioconjugates. In the short term, **HyPhoto^2** will focus on the development and optimization of hybrid nanocomposites. In the long term, the use of improved hybrid nanocomposites could lead to a breakthrough in photomedicine.