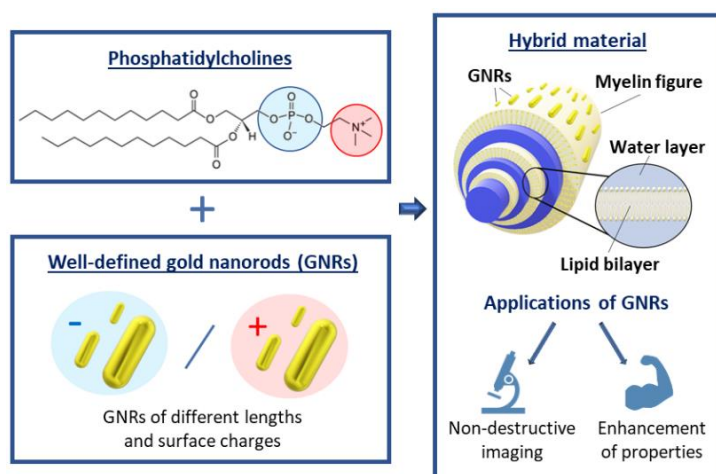


Gold Nanorods for Lipidic Mesophases Imaging and Modification (GLIM)

In recent years, a significant focus of research on soft matter has been the development of new concepts to enhance understanding of biological structures exhibiting liquid crystalline properties. A well-known example of biologically relevant mesophases is an elongated microstructure composed of concentrically wrapped phospholipid bilayers, known as **myelin figure (MF)**, highlighting its similarity to the myelin sheath. This lipid-rich biomembrane promoting rapid nerve impulse propagation is the target of several pathological pathways involved in incompletely understood and incurable disorders of the central nervous system, such as multiple sclerosis. The disruptions in multilamellar lipid assemblies cause less efficient transmission of nerve impulses. Therefore, significant effort has been devoted to gaining insight into the mechanisms underlying its instability using model structures, which may lead to advances in diagnosing and treating demyelination diseases. Nevertheless, **employing non-invasive methods to detect early-stage small-scale morphological changes within myelin remains a challenge**. Interdisciplinary studies on lipidic mesophases may provide new perspectives for *in vitro* and *in vivo* imaging. In this context, **combining gold nanorods (GNRs) with MFs** may lead to the development of a new approach employing **two-photon excited fluorescence microscopy to detect subtle changes within lipid-based structures in three dimensions (3D)**.

Among various nanomaterials, **GNRs have been successfully implemented as probes in bioimaging** since they exhibit **two-photon excited luminescence** upon highly efficient absorption in the so-called biological window (within the NIR). Using light from this spectral range gives several advantages, such as deep tissue penetration and reduced phototoxicity. Extensive work in coupling gold nanoparticles (GNPs) to biomembranes has been devoted to simplified lipid-based structures, **mainly in the form of unilamellar vesicles**. Moreover, studies on the interactions of GNPs with the surface of vesicles are primarily **limited to gold nanospheres**. Besides, in the literature concerning the potential use of GNRs for light-induced changes in the myelin sheath, **there is a lack of criteria for selecting GNPs with specific structural and optical properties**. Thus, in the GLIM project, we aim to conduct **systematic studies to choose the most advantageous GNRs for applications in research on natural myelin using more complex models in the form of MFs**.



In the first step of the GLIM project, we plan to synthesize GNRs with various geometric parameters, functionalize their surfaces, and characterize their optical and structural properties. A crucial aspect of the research will be **developing an original method for preparing hybrid materials composed of lipid bilayers and GNRs**. We will characterize the obtained materials using spectroscopic methods and advanced microscopy techniques, such as two-photon microscopy with polarization and temperature control. We will begin by exploring **unilamellar vesicles and MFs composed of a single type of phosphatidylcholines**, a class of phospholipids commonly found in biomembranes. We speculate that properly designed GNRs could improve the thermal stability of lipidic mesophases. Nevertheless, the lack of statistically significant correlation between the investigated properties within hybrid materials may allow us to use specific GNRs as non-invasive markers for imaging multilayered lipidic mesophases. In the next step of the research, we will conduct **studies on more complex models made of mixtures of lipids resembling the lipid composition of native and lesioned membranes**.

The first outcome of the GLIM project will be a **better understanding of GNR-lipid bilayer interactions** and **determine the influence of these GNPs on the phase behavior of lipid-based MFs to design novel hybrid materials with precise control over their morphology and thermal stability**. The second outcome of the project will be the **development of a novel approach to image the 3D morphology of lipidic mesophases of biological significance**.