

Bionanotechnology is a discipline that demonstrated its existence as a merge of the structural biology and biomaterials sciences. Biomaterials science is defined as any material that is intended to have a contact with living forms, in particular related to the medical applications (artificial implants, plates, valves etc). Bionanotechnology however works on the **cellular and molecular level**, but has an impact on the macroscopic scale and includes genetic therapies, drug delivery systems, genetic analysis and more recently **nano-particles** and **nano-objects** design and bioapplications.

Nucleic acids based materials are of the interest due to their intrinsic programmable properties, biocompatibility and specific recognition potential. In biological system, sequence specific recognition potential can lead to the regulatory function, *via* antisense theory or RNA interference. Since the discovery of RNA interference (RNAi) there have been numerous reports of successful implementation of this methodology towards tumor suppression in complex organisms such as mice, non-human primates and recently in humans. It is believed that small RNAs will become **new class of therapeutics** in the near future. Short dsRNA can be chemically synthesized and modified to ensure the enzymatic stability within cellular system. However a proper recognition of target cells and the delivery methods are not suitable for current siRNA to be applied on humans. Therefore **multiple functionalities** have to be combined in single transfection particle to be successfully used in gene regulation therapy. These obstacles can be targeted by the multifunctional **tecto-RNA nanoparticles**.

The main goal of this project is to design the RNA nanoparticles that combines multiple elements: implemented regulatory fragments, specificity elements and reporting groups, which can be traced in cellular matrix, or in tissues. As compared to the small interfering RNA (siRNA) class of double-stranded RNA molecules, the tecto-RNA nanoparticles can be designed to regulate multiple genes using single unit. Because of parallel regulatory pathways, shutting off one particular protein in the cellular system will probably not destroy it, but orchestrated suppression of multiple anti-apoptotic genes can lead to the programmed cell death.

This project combines the **multidisciplinary approach of computational design, chemical and enzymatic synthesis tools and biological assays**. The aim is to design smart (responsive) RNA nanoparticle that will be able to find and change (or destroy, if needed) the target cell. Such object has to be well defined; yet the preparation has to be relatively simple and reproducible. Using RNA materials provides unparalleled recognition potential, where specificity is reached by sequence complementarity. However, the biggest advantage is the RNA based materials is the biocompatibility. The impact of this project is also on basic research, specifically throughout the improved understanding of RNA-RNA and RNA-protein interaction, RNA self-assembly processes and application research with potential implementation of functional RNA nanoparticles.