PROJECT TITLE

Macrocyclic Derivatives for Biomolecule Delivery

KEYWORDS

Organic Chemistry, Supramolecular Chemistry, Macrocycles, Molecular Interactions, Biomolecule Delivery

TUTOR

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DESCRIPTION

Controlled delivery of exogenous biomolecules within the organism is a research field of high interest nowadays, due to the extraordinary development experienced by technologies based on nucleic acids and proteins. Biomedical applications such as mRNA-based vaccines, gene editing techniques with the CRISPR-Cas system and many others base their action mode on directing specific biomolecules to precise locations within target cells. This is not an easy tasks very often due to the natural mechanisms that living beings have evolved to maintain their biological integrity and be safe from unwanted intruders. In addition to overcoming multiple biological barriers, it is necessary for biomolecules to reach their target in a functional form so that they can fulfill their mission.

In order to advance in this field, our research group designs and develops new biomolecule delivery systems based on macrocyclic derivatives. Macrocyclic molecules present a series of unique characteristics that make them very interesting for the development of these systems. On one hand, they allow the design of well-defined polyfunctional systems in a relatively simple way, falling halfway between small polymers and monomers. With the high density of functional groups of the former and the molecular definition of the latter. In addition, macrocyclic molecules often have unique and characteristic supramolecular properties. These can be molecular inclusion properties (they are able to recognize and bind to other molecules) or physicochemical properties such as fluorescence, electron transfer, etc. There are several types of macrocycles with different and complementary properties that can be employed to build biomolecule transport systems and endow them with specific functionalities. Thus, allowing us to design increasingly precise and reliable transport systems specifically adapted to the characteristics required by each application.

This project focuses on advancing the technologies previously developed in the group for the transport of nucleic acids and proteins using organic and supramolecular chemistry strategies. New designs of transport systems based on macrocycles (mainly derivatives of cyclodextrins and porphyrins) will be built with the aim of improving control over their activity within cells or organisms by incorporating functional groups able of responding to specific external stimuli. This work includes the detailed and exhaustive characterization of the new systems and their supramolecular behaviour through advanced chemical characterization techniques (NMR, MS, ITC, DLS, etc.).