Probing the Stability of Biological Molecules in Deep Eutectic Solvents

Place of work: BioISI - FCUL Edificio C8, piso 5; School of Science and Technology of Nova University of Lisbon

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Deep eutectic solvents (DES) are an emerging class of liquid mixtures characterized by a depression of their melting points, relative to those of the constituent components. Most DES are formed by a quaternary ammonium salt and a hydrogen bond donor. In addition, water can be used to further tailor the properties of the DES. These solvents have recently started to be studied in multiple chemical and biochemical processes. Examples of the latter include their ability to stabilize biological molecules, ranging from enzymes to mRNA. A key question concerns the amount of water required to allow proteins to maintain their secondary structure and their function, and whether enzymatic activity can be enhanced in specific DES. Another potential application regards the possibility of preserving mRNA conformation at room temperature in DES, circumventing the need for storage at very low temperatures, necessary for example for mRNA-based vaccines such as for COVID-19.

In this project we aim to study, through a combined molecular simulation and experimental approach, the structure of either a protein or of a mRNA strand in a DES, at room temperature. This proposal is part of a larger project to be developed in collaboration with the Nova University of Lisbon where experiments will be carried out to determine the effect of water content and temperature in protein structure by, for example, circular dichroism and FTIR. The main goal of the project is twofold (1) understanding the structural transformations of the biological molecule of interest in a DES and its dependence on the water content and (b) the molecular nature of the DES-biological molecule interactions, at the origin of these structural transformations. The extent of the simulation and experimental components of the project are flexible and can be discussed with the candidate. The molecular simulations will be carried out at BioISI-FCUL under the supervision of the researcher Nuno Galamba. The experimental component will be performed at the School of Science and Technology of Nova University of Lisbon under the supervision of the researcher Alexandre Paiva.