FINAL MASTER PROJECT PROPOSAL

Title

DNA-polymer Hybrids by Dynamic Covalent Chemistry

Supervisor(s)

Supervisor: Jesús del Barrio Lasheras (Ramón y Cajal research scientist at INA)
Supervisor: Silvia Hernandez Aínsa (ARAID research scientist at INA)

Summary of the project

The area of Dynamic Covalent Chemistry (DCC) explores the design and self-assembling properties of molecules and macromolecules which are able to establish reversible covalent bonds. DCC marries the benefits of covalent and non-covalent synthesis (i.e. intrinsic responsiveness and error correction) and is therefore an excellent tool for the development of materials with emerging properties such as recyclability, facile processability and self-healing capabilities. A promising dynamic covalent interaction is the boronic acid mediated condensation of aryl aldehydes (electrophiles) and amines (nucleophiles). These building blocks are able to engage in strong, but reversible, covalent interactions in aqueous media. This project will investigate the self-assembling properties of specific macromolecular building blocks, including DNA strands, and the formation of responsive hybrid micelles in water.

The coating of DNA origami structures with water soluble polymer chains following the principles of DCC will also be evaluated. Such hybrid systems are of interest in a broad range of biomedical areas including gene therapy, drug delivery and biosensing. The characterisation of new functional polymers will be performed by means of NMR, FT-IR, elemental analysis and mass spectrometry. Many additional characterisation techniques will be necessary to demonstrate the formation of dynamic covalent micelles and coated structures including isothermal titration calorimetry, AFM, TEM, variable temperature UV/Vis, circular dichroism and gel electrophoresis. The necessity of having two supervisors with complementary backgrounds is associated with the multidisciplinary nature of the project, which includes the synthesis of new organic compounds, the preparation of DNA complexes and specific physico-chemical studies.