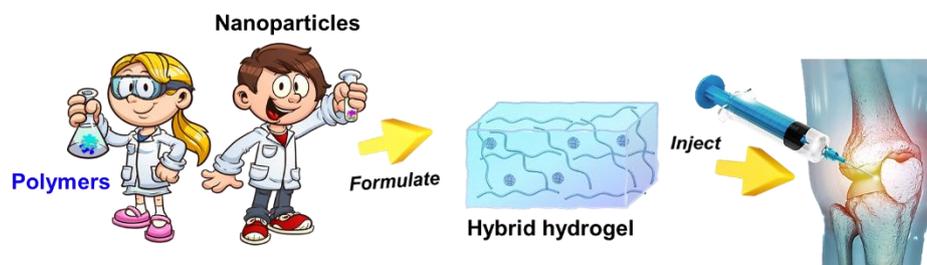


MASTER 2 INTERNSHIP OFFER (6 months, from January/February 2026)

Hybrid hydrogels for sustained peptide delivery in the joints

Imagine having the opportunity to slow the progression of osteoarthritis and alleviate its painful symptoms: this would be a real game-changer for patients!

Hydrogels are water-swollen three-dimensional networks made of hydrophilic and amphiphilic natural and synthetic polymers. Due to their water content, porous structure and soft nature, biodegradable polymer hydrogels have gained



a wide interest for a broad range of biomedical applications.^{1,2} Among them, injectable hydrogels are extremely promising as reservoirs for localized drug delivery, aiming to enhance drug bioavailability and optimize pharmacological activity while minimizing systemic toxicity.³

When used for locoregional administration, these gel-based materials can effectively retain drugs and release them in a controlled manner, ensuring high local concentrations of the drug while reducing the required dose and frequency of administration compared to systemic administration.

In this context, intra-articular (IA) administration holds promise for the treatment of degenerative joint diseases, such as osteoarthritis (OA).

Although these hydrogels may appear as an attractive alternative to current treatments, insufficient benefits have been obtained so far. The main challenges are their poor mechanical strength and the rapid release of only physically encapsulated drugs. However, the performance of hydrogels can be improved by combining them with nanoscale drug carriers.^{4,5}

We are currently working on this topic and we are designing a hybrid system through the precise engineering of a hydrogel matrix and medicated nanocarriers. The latter are loaded with a recently identified peptide (Collaboration with Dr Cailotto, IMOPA, Lorraine University) with already validated activity on arthritic cartilage degeneration.⁶

Now we aim to rationally ascertain how the combination of the building components will enable to meet the specified requirements. The hybrid systems need to possess injectability, appropriate mechanical strength, and achieve a desirable drug payload with controlled spatio-temporal release.

Methodology

Formulation and characterization of drug loaded nanoparticles

According to its hydrophilic nature, peptide loaded nanocarriers will be prepared by water-in-oil-in-water double emulsion solvent evaporation method using biodegradable polymers. Formulated nanocarriers will be characterized in terms of size, morphology and surface charge. Colloidal stability and drug release will be assessed in different media representative of the physio-pathological conditions (e.g., 37° C, phosphate buffer, serum-containing cell culture medium, healthy and arthritic synovial fluid).

Formulation and characterization of the hybrid hydrogel

Hydrogels will be prepared by physically mixing an appropriate volume of nanocarriers with the hydrogel precursors chosen for their biodegradability and biocompatibility. The resulting hybrid hydrogel will be characterized in terms of macromolecular structure, drug loading, gelation time and temperature, swelling behavior, rheological and mechanical properties. The drug release kinetics will be determined in different media (PBS, human plasma, synovial fluid).

References

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4. P Thoniyot, MJ Tan *et al.*, *Adv. Sci.* **2015**, 2, 1400010 [10.1002/advs.201400010](https://doi.org/10.1002/advs.201400010)
5. A. Li, J. Nicolas, S. Mura, *Adv. Funct. Mater.* **2024**, 35, 2409670. <https://doi.org/10.1002/adfm.202409670>
6. <https://theses.fr/2020LORR0127>

Candidate profile

Are you a curious and motivated student, looking to explore nanotechnology and drug delivery? Are you fascinated by the possibilities offered by biodegradable polymers, nanoparticles, and hydrogels?

We're looking for someone who

- Has a solid background in physico-chemistry, polymer chemistry, pharmaceutical sciences and/or biomedical engineering;
- Has hands-on experience in nanoparticle & hydrogels formulation and characterization
- Is enthusiastic to further develop these skills and apply them to hybrid systems;
- Is comfortable with rheology measurements and analyzing the mechanical and flow properties of materials using a rheometer;
- Is excited to use High-Performance Liquid Chromatography (HPLC) to precisely track drug release profiles;
- Can read and understand scientific literature;
- Takes on scientific problems and challenges with creativity and dedication;
- Reports experimental results clearly;
- Wants to collaborate with a dynamic team of researchers.

If this sounds like you, we want to meet you!

Please send us your CV, a short motivation letter, the contact details of your former supervisors and list all the technical skills you possess, indicating your level of experience for each (e.g. basic, intermediate or advanced).

Host Institution

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Hosting Team

Nanomedicine for the treatment of severe diseases

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