



Master/3rd year engineer
RESEARCH INTERNSHIP



From Molecular Activity to early stage Osteoarthritis Diagnosis

Developing a cutting-edge workflow to detect active enzymes in human synovial fluid

Period: 6 months from January/February to June/July 2027

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Internship locations: IBMM, Pôle Chimie Balard, Montpellier, www.ibmmpeptide.com - IRMB, Institut de Médecine Régénérative et Biothérapies., irmb-montpellier.fr.

The work will take place mainly at the IBMM in Montpellier, and IRMB for biological evaluation.

Scientific context and challenge : Osteoarthritis is a major and growing global health burden, driven by population ageing and by environmental and lifestyle-related factors such as occupational stress, joint injuries and overweight. Despite its high prevalence and impact on quality of life, early diagnosis remains challenging, while biological alterations may occur years before clinical symptoms appear. How can we detect these early molecular alterations and, more importantly, distinguish what is present from what is properly active ?

Matrix metalloproteinases (MMPs) are key enzymes involved in cartilage and extracellular matrix degradation. They are therefore promising biomarkers of osteoarthritis. However, conventional methods mainly measure the total amount of MMPs, without distinguishing active enzymes from inactive or inhibited forms, meaning that a crucial piece of functional information may be missed.

The innovation : We have developed an innovative activity-based profiling (ABP) strategy coupled to MALDI mass spectrometry that selectively labels and detects active MMPs, even in complex biological samples. The next challenge is to determine whether this technology can detect endogenous active MMPs directly in human synovial fluid. This project will therefore combine protein chemistry, sample preparation, biochemical assays and mass spectrometry to establish a powerful functional biomarker detection.

Your mission : You will work at the interface of Chemistry, Biology and Medicine, and will apply activity-based chemical probes to selectively label active MMPs in biological fluids, optimise the preparation of complex synovial fluid samples, analyse samples by MALDI-MS, identify and quantify active MMPs.

What you will learn : you will develop practical and transferable skills in understanding and applying activity-based chemical probes, tagging and evaluate active enzymes in complex biological matrices, handling and processing challenging biological fluids; preparing mass spectrometry sample, acquiring and interpreting data, extracting and interpreting molecular and enzymatic information from experimental data.

Interdisciplinary research: working at the interface of Chemistry, Biology and Medicine

Scientific problem-solving: designing experiments, troubleshooting protocols and critically analysing results.

You will gain experience in a research environment combining fundamental chemistry, biomedical research and translational objectives.

Why this project?

Beyond establishing an experimental proof of concept, the project will contribute to a publication and could provide the starting point for future project, investigating how biological dysregulation may influence osteoarthritis progression.

A challenging project at the Chemistry - Biology - Medicine interface, with a clear translational perspective.

Références :

1. Steinmetz, J. D. et al. Global, regional, and national burden of osteoarthritis, 1990–2020 and projections to 2050: a systematic analysis for the Global Burden of Disease Study 2021. The Lancet Rheumatology 5, e508–e522 (2023).
2. Berthy, L. et al. Proximity-Induced Transfer of a Mass Tag Enables Direct Profiling of Active Matrix Metalloproteases. Angewandte Chemie International Edition n/a, e23132 (2026).
3. Devel, L. et al. Covalent Labeling of Matrix Metalloproteases with Affinity-Based Probes Containing Tuned Reactive N-Acyl-N-Alkyl Sulfonamide Cleavable Linkers. ChemBioChem 25, (2024).
4. Jarecki, J., et al. Concentration of Selected Metalloproteinases and Osteocalcin in the Serum and Synovial Fluid of Obese Women with Advanced Knee Osteoarthritis. Int. J. Environ. Res. Public. Health 19, 3530 (2022).