Soutenance de thèse

Vendredi 29 Septembre

14 h, Amphithéâtre C2N

Coupling of thermoelectric and electrochemical measurements in microfluidics for microRNA detection

Martina Freisa

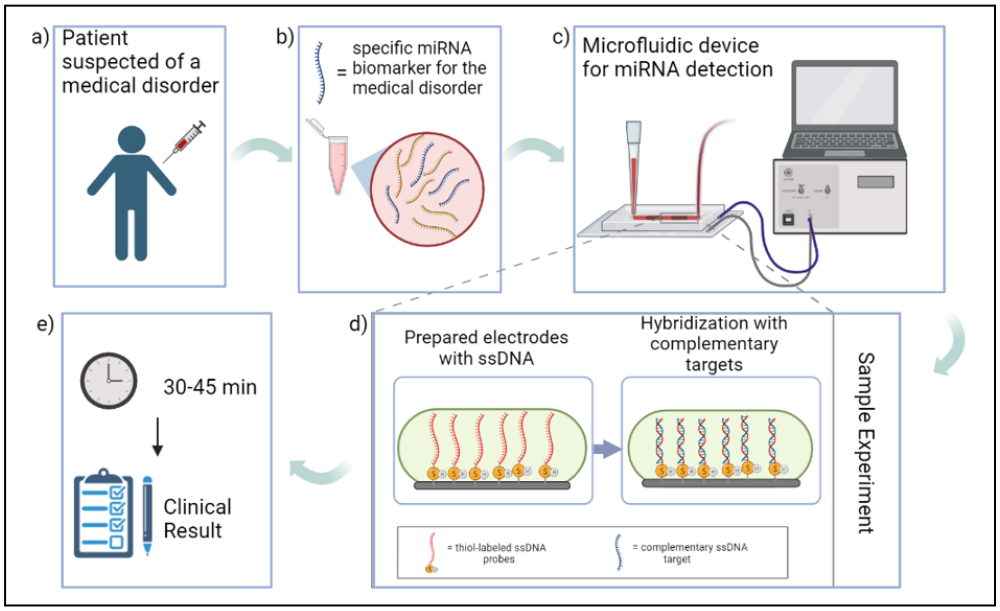
Encadrement

Jean Gamby, Ph.D. director
Isabelle Le Potier, co-supervisor

- Les membres du jury :
- Rosaria Ferrigno, Prof. at Universite Claude Bernard Lyon 1. Rapporteure
- Luigi Falciola, Prof. at Università degli Studi di Milano. Rapporteur
- Elie Lefeuvre, Prof. at University of Paris-Saclay. Examinator
- Laurent Thouin, Research Director at Ecole Normale Supérieure. Examinator
- Sandrine Le Guillou, Research Engineer at Institut National de Recherce pour l'Agriculture, l'alimentation et l'Environnement. Invited

Abstract :

Circulating microRNAs (miRNAs) are short non-coding RNAs composed of 19-25 nucleotides and present in various bodily fluids, including blood, serum, saliva,urine, and breast milk. The alteration of miRNA expression has been deeply investigated in recent years, and it was found to be associated with several disorders comprising cardiovascular diseases, cancers, and neurodegenerative conditions. In this context, Dr. Gamby at the Center for Nanoscience and Nanotechnology (C2N) launched some research projects to develop microfluidic platforms for miRNA detection via electrochemical biosensors. My Ph.D. thesis aims to design, fabricate and characterize a microfluidic device that can detect mi-croRNA (miRNA) by coupling thermoelectric and electro-chemical measurements.
Electrochemical biosensors are transducers in contact with the analytes under detection, transforming physical or biochemical reactions into an electrochemical signal. The biosensor utilizes single-stranded DNA (ssDNA) probes immobilized on the electrode surface to recognize the target miRNA molecules. Moreover, integrating the thermal sensor permits measuring the heat released during the hybridization between the ssDNA probe and the miRNA target, which is peculiar to each sequence, allowing higher specificity to the detector. In this Ph.D. thesis, I present two microfluidic devices englobing different sensors. Notably, the electrochemical biosensor employs gold for the first device and platinum for the second one. In addition, the first chip is equipped with a thermopile, while the second one comprises a resistance thermal detector (RTD). The second microfluidic device developed permitted the electrochemical detection of the target miRNAs at three concentrations: 10^{-14} M, 10^{-10} M, and 10^{-6} M. Moreover, real sample experiments are conducted, allowing distinguishable results between wildtype mice milk presenting normal levels of miRNA 30b and transgenic milk samples enriched with miRNA 30b. In parallel, the microcalorimeter permitted real-time monitoring of the self-assembled monolayer formation with ss-DNA probes



The schematic explains the aim of microfluidic devices for miRNA detection: a) A bodily fluid test analysis is performed to a patient. b) The test aims to quantify a specific miRNA that has been identified as biomarker for a medical disorder. c) The analysis can be conducted in a simple laboratory by the use of the microfluidic chip. d)The biosensors permit the detection and quantification of the target miRNA by biorecognition. e) Providing faster results compared to traditional methods.