Molecular Imprinted Polymers as Enzyme Mimics for Decontamination of Sulfur and Organophosphorus Toxic Derivatives

Acronyme: **MIPEnz-Decontam**

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Abstract :
The aims of the MIPEnz-Decontam multidisciplinary project is to develop innovative and **decontamination devices and tools** allowing neutralization and detoxification of sulfur derivatives such as gas mustard, and neurotoxic organophosphorus agents such as chemical warfare agents and pesticides. To reach this polyvalence level, our research hypothesis relies on the implementation of an unique innovative **biomimetic approach** consisting in the conception of **enzyme mimics**, such as multifunctional **Molecular Imprinted Polymers (MIP).**

CONTEXT and OBJECTIVES

Chemical warfare agents (CWA) and pesticides are a major concern related to defense and public health issues. Among them, **vesicants** and **nerve agents** are considered to be the most nefarious and dangerous compounds. The synthesis of chemical weapons being quite easy, they potentially attract terrorist groups and facilitate their use in asymmetric conflicts. Intoxications are possible because large stockpiles of military grade nerve agents and sulfur mustards (HD) still exist in many countries, despite the signature of the Chemical Weapons Convention.

Furthermore, **N**eurotoxic **O**rgano**P**hosphorus compounds (NOPs) are still used in agriculture and constitute one of the most widespread pesticides worldwide. Consequently, approximately 3 millions of intoxications due to NOPs are reported each year, most of which are fatal for the patients. Despite recent progress in the **decontamination** and **detoxification protocols** CWA, the chemical defense presents undeniable shortcomings and severe limitations. Today, for the safety and health of the soldiers and the civil population, there is a **crucial need** to develop new and **efficient technologies,** eco-friendly and cost-effective, for the decontamination of NOP and vesicants.

Consequently, our **objectives** are to tailor MIP-based porphyrins and corroles with selective aerobic oxidative properties, to decontaminate 2-ChloroEthyl Ethyl Sulfide (CEES: HD simulant), HD and VX; and to tailor MIP-based cyclodextrins and MIP-based a-nucleophiles endowed with hydrolytic properties to decontaminate broad spectrum of NOPs. **MIPEnz-Decontam** strategies are original since the conception of the MIPs will exhibit a well-defined hierarchical catalytic site, expected to provide, ultimately, spontaneous oxidation of sulfide/VX and hydrolysis of CWA.

METHODOLOGY and RESULTS

Methodology: Recently, **the proof of concept of this strategy has been validated** in the case of sulfur derivatives (Rouen team, F. Estour), and we emphasized that in the frame of **MIPEnz-Decontam** we could target the decontamination of a wide range of CWA. The studies will be focused on the development of innovative MIPs based on a corrole/porphyrin (Bourgogne Team, C. Gros) (Figure 1a), to oxidize HD/CEES/VX, and on cyclodextrin-core (Rouen team, F. Estour), and the use of new MIP-based α-nucleophiles (CNRS Team, R. Baati and Rouen Team P.-Y. Renard) to hydrolyze NOPs (Figure 1b).

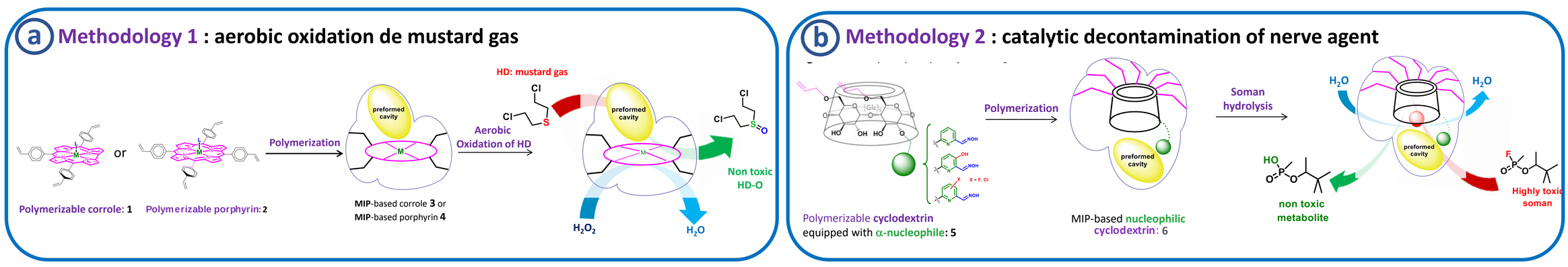

***Figure 1**: Schematic representation of our innovative integrated approaches based on functional MIP*

Results: To reach our challenging goals, after the April 2021 kick-off meeting of the consortium, all partners have successfully started the planed tasks, and we are delighted to share that the chemical synthesis and characterization of functionalized corroles, porphyrins and cyclodextrins are progressing (Task 1: P2, P3).
Additionally, the chemical synthesis and characterization of new functional α-nucleophilic compounds and cyclodextrin derivatives were implemented (Task 2: P1, P2). Up to now, promising preliminary results have been obtained on the chemical synthesis and characterization of original scaffolds, and will be reported in due course.

LOGOS PARTENAIRES