MSc in Biotechnology/Biochemistry/Biochemistry in Health/Bioorganic Chemistry
Dissertation Project – 2nd Cycle

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Scientific area: Biotechnology, Molecular modelling, Biosensing  
TITLE: Mimicking olfactory receptors and their interaction with microbial volatiles

BACKGROUND

Bacterial infections can cause sepsis with high associated mortality rates (14-50%), representing a significant economic burden. In particular, antimicrobial resistant bacteria are a great concern in public health. Over 25,000 people die annually in the EU from antimicrobial resistant pathogens. Apart from the victims, these infections result in extra healthcare costs exceeding €1.5 billion a year in EU. Hospital and community-associated multiresistances are becoming more frequent, and likely to increase due to the ageing of the European population and the actual economic crisis. But bacterial infections can affect anyone. Early-detection and confinement of the infected individuals are the only ways to provide targeted antibiotic treatment and control infection spread.

The “gold standard” for detection and identification of infections in clinical settings, is still based on blood cultures. Typically, it takes at least 24-36h to check for the presence of bacteria, have an antibiotic susceptibility profile and define the best therapeutic approach. But for slow-growing bacteria, as those causing tuberculosis, these analyses can take more than a week.

Electronic noses are sensors able to detect volatile compounds with great sensitivity and to reproduce the human senses. It is possible to take advantage of the distinctive properties of the gas molecules emitted by biological cultures to detect different microbial species by smell. These molecules are produced by the metabolisms of the biological cultures, and are species-specific.

OBJECTIVES

The human olfactory system can discriminate over 10,000 distinct odorants, whereas animals and insects possess an even vaster olfactory detection system. The detection of odorants results from a combinatorial response, in which a library of odorant binding proteins and activated olfactory receptors gives a unique fingerprint of each odorant. Trained animals, for example dogs and bees, can serve as living nose sensors, although representing a controversial approach with a difficult implementation and portability.

Our group has recently discovered a new and revolutionary class of nano-polymeric systems for e-nose assembly. These systems are able to detect volatile organic compounds but with very low selectivity. The aim of this project is to increase the selectivity of the detection system for the fast detection of human pathogens by creating small molecules which mimic olfactory receptors. This can have a huge impact in infectious disease control, saving lives and reducing healthcare costs.
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**PROJECT DESCRIPTION**

The project will involve:

(i) Understanding the structural features of the molecular recognition between olfactory receptors and microbial volatiles.
(ii) Design small molecules with mimicking the interaction between olfactory receptors and volatiles
(iii) Produce and screen a combinatorial library of peptides and peptidomimetics towards volatiles
(iv) Utilize the new mimetics for the selective detection of microbial volatiles
(v) Characterize the volatile-sensitive materials produced (SEM, POM, AFM, DLS)
(vi) Thesis writing

A student enrolling in this project will have a unique opportunity to acquire a wide range of expertise in molecular modelling of biological molecules, combinatorial biology & combinatorial chemistry, high-throughput screening techniques, biomaterials, nanomaterials science, sensor development, microbiology and clinical diagnostics.

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