MIND LAB: Molecular Innovation & Design Laboratory

Blueprints of Bioactivity: From Structures to Antimicrobial Resistance

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Antimicrobial resistance (AMR) is a major global threat to public health, food security, and sustainable development. In 2024, AMR was linked to approximately 1 million deaths and contributed to nearly 5 million globally [1]. In the European Union, AMR causes around 133,000 deaths annually and costs €11.7 billion due to healthcare and productivity losses [2]. The crisis is further compounded by parasitic diseases such as malaria, which caused 249 million cases and over 600,000 deaths in 2022; moreover, resistance to existing treatments is rapidly increasing [3]. Therefore, addressing antimicrobial resistance is crucial for achieving the 2030 Sustainable Development Goals.

To address these challenges, the development of new bioactive compounds remains a critical research priority. This talk highlights recent advances in the design, synthesis, and biological evaluation of coordination polymers, metal complexes, and organic compounds as potential antimicrobial agents. These molecular systems not only exhibit promising activity against resistant pathogens but also offer structural versatility for further functionalization [4,5]. Moreover, the construction of hybrid materials incorporating coordination polymers as antimicrobial dopants is currently under active investigation, with the aim of enhancing their stability, efficacy, and targeted delivery [5].

The talk also outlines key research themes currently under development at the *MINDLab – Molecular Innovation & Design Laboratory*, where interdisciplinary strategies are employed to design and synthesize bioactive compounds as prospective antimicrobial agents. These efforts seek to elucidate the relationship between molecular architecture and biological activity, particularly in the context of antimicrobial resistance and neglected diseases.

Keywords: *Bioactive compounds*, *Coordination polymers*, *Uracil derivatives*, *Antimicrobial resistance*, *Structure–activity relationships*

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