Polymer molecular weight, unresolved issue of polyamines biological activity

Multi-drug-resistant (MDR) bacteria are becoming an increasingly frequent topic in the news—and for good reason. These dangerous microorganisms threaten global health systems, posing a particular risk to vulnerable individuals, such as very young children and older patients. In 2019 alone, antimicrobial resistance contributed to an estimated 4.95 million deaths worldwide. This alarming trend underscores the urgent need for innovative antibacterial solutions.

One promising path in the fight against MDR bacteria involves antimicrobial polymers. These substances, particularly polycations (positively charged polymers), directly target the membranes of bacterial cells. Their mechanism is simple yet devastating: they disrupt the bacterial membrane, effectively neutralizing the microorganism. Our research focuses on these polymers to explore their potential as new antibiotics or antiseptics.

Unlike conventional drugs, polymers are not single, well-defined molecules. Instead, they are collections of molecules with varying chain lengths and masses. Interestingly, this variability can influence their biological activity, such as their antibacterial effectiveness. However, the relationship between a polymer's chain length and its activity remains poorly understood.

In this project, we aim to understand why certain polyamines behave differently depending on their molecular size. This understanding is essential before antimicrobial polymers can be effectively used as antibiotics or incorporated into products like antibacterial plastic packaging.

Our ultimate goal is to design better antimicrobial polymers—ones that are highly effective against bacteria while being safe for humans and other higher organisms. The insights gained from this research may also improve regulations governing the use of polymers in pharmaceuticals and shed light on the toxicity of polymers from everyday sources, an issue of growing public concern.