Polyphosphate and DNA as scaffolds for proteins during stress and normal growth

For many decades, bacteria - in contrast to the highly organized cells of higher organisms - were considered as containers with a randomly distributed and homogenous mixture of macromolecules. Based on the recent discoveries, it became clear, that bacteria also display very complex and dynamic intracellular organization. Although they do not possess classical organelles (such as mitochondria or nucleus), the cellular compartmentalization for distinct biochemical reactions is provided by membrane-less organelles. Such structures include inorganic polyphosphate (PolyP) granules, which are formed under stress conditions. To date, we still lack the full understanding of PolyP granules' structure, composition, and function in bacteria. We hypothesize that PolyP granules and bacterial chromosomal DNA may provide alternative scaffolds for a number of proteins that give them the possibility to temporally change their intracellular positions, local concentrations, partners for interactions, and therefore stability and activity. In this project, we plan to investigate the molecular mechanisms responsible for the assembly and disassembly of the PolyP-granules and track proteins exchanging their interactions with these two scaffolds. The main goal of this project is the characterization of this specific regulatory switch between scaffolds in the context of bacterial survival in stress conditions. We plan to identify PolyP interacting proteins and describe how they affect granule formation. We will investigate if any proteins can create a direct bridge between PolyP granules and chromosomal DNA. In this research project, we will take the advantage of the most advanced techniques such as Atomic Force Microscopy or high-resolution fluorescent microscopy. These techniques allow single-molecule localization and the real-time analysis of individual protein or PolyP molecules. The understanding of regulatory mechanisms in bacterial cells during stress conditions has fundamental importance for the development of new methods to fight pathogenic bacteria and prevent overspreading of multi-drug resistance that makes conventional therapies invalid.