# Viral Protection through Advanced Polymeric Excipients for Biomedical Applications

## Abstract for the general public

Bacteriophages, viruses that specifically infect bacteria, are emerging as a promising alternative to antibiotics, particularly as bacterial resistance to traditional treatments continues to rise. Research has demonstrated their effectiveness in combating dangerous bacterial infections, with potential applications in medicine, food safety, and environmental protection. However, despite their advantages, the widespread use of bacteriophages is hindered by stability issues - they degrade when exposed to temperature fluctuations, drying, or long-term storage. This instability limits their effectiveness, complicates their transport and distribution, and poses a major challenge to their implementation in therapeutic and biotechnological applications.

This project aims to develop innovative stabilization methods for bacteriophages, allowing for improved storage conditions and enhanced usability. The research will focus on using polymers, specially designed protective substances that can shield phages from degradation. By investigating the effects of different polymer compositions, we will establish optimal stabilization strategies that enhance phage resilience under various storage and transportation conditions.

The project integrates polymer chemistry, biophysics, and microbiology, creating an interdisciplinary approach to virus stabilization. A key aspect of the research involves advanced analytical techniques, such as small-angle X-ray and neutron scattering (SAXS/SANS), which will provide detailed nanoscale insights into how bacteriophages interact with polymeric stabilizers. This knowledge will not only improve our fundamental understanding of phage stability but also enable the development of more effective protective formulations.

In addition to bacteriophages, the project will also investigate proteins and virus-like particles (VLPs), which play a crucial role in modern vaccine development. VLPs mimic the structure of viruses but lack genetic material, making them safe and highly effective as vaccine components. However, their stability remains a challenge, complicating their production, storage, and distribution. By applying polymer-based stabilization techniques, this research could significantly enhance the durability of VLP-based vaccines, contributing to advancements in biotechnology and pharmaceutical sciences.

The expected outcomes of this project include the development of novel stabilization strategies for viral biological formulations, with applications in phage therapy, biotechnology, and vaccine production. Through international collaboration between Polish and Chinese research teams, the project will leverage cutting-edge research methodologies and technological advancements to create innovative, scalable, and cost-effective stabilization methods. Beyond advancing scientific knowledge, the project could have significant implications for the development of new antimicrobial therapies and improved vaccine accessibility, particularly in regions where maintaining a cold-chain infrastructure is a challenge.