Antiviral nanoparticles and polymers to selectively fight phage infections without harming bacteria and eukaryotic cells

Viruses are parasites with living cells as their hosts. Without cells, viruses cannot perform their live cycle. Often viruses cause the host's death upon release of the number of copies of virions. Cascade of progeny virions attack neighboring cells or transfer to another host organism. Some viruses attack animals and humans, causing various diseases (like HIV, HPV, Hepatitis A and B, influenza, rotavirus, Zika, rubies, to name only a few), plants (Tabaco mosaic virus), or even bacteria (bacteriophages). The COVID-19 pandemic gave the realization that we do not have suitable antiviral measures to provide the necessary protection.

The proposed project within Opus-23 call focuses on fighting viruses attacking bacteria – named bacteriophages, or phages for short. Phages cause serious problems when they infect the bacteria-based biotechnological factories. Within hours a single bacteriophage can be multiplied in millions of copies utilizing the biochemical machinery of the host. In each bacterial cell, up to a few hundred copies are formed and released. This usually results in the death of bacteria. Phage infections have profound repercussions as bacteria-based processes are one of the most important in biotechnology and dominate many branches of industry which exploit the natural metabolic capabilities of bacteria to produce active substances. All factors, which affect bacteria-based factories, cause millions of dollars in losses.

Here, we propose the strategy to obtain antiphagents (antibacteriophage agents) that will be safe for bacteria and eukaryotic cells. This will allow online protection against phage infections. We will synthesize, purify, and characterize “mixed” (bearing positively charged, negatively charged, neutral and hydrophobic domains) nanoparticles and polymers and test them against model phages (T1, T4, T7, M13, MS2, phi6, PhiX174, QBeta), bacteria, and eukaryotic cells. We will tune the composition of the “mixed” domains to assure efficacy against virions and safety towards cells.

The knowledge gained upon realization of the project might also be utilized against pathogenic viruses attacking humans, helping to fight against numerous diseases. Among the many bacteriophages, some (MS2, phi6, PhiX174, QBeta) are considered good surrogates for studies on eukaryotic, often dangerous, viruses.