Disposable plastic products became an integral part of our everyday life since the start of their production in the 1950s. Cheap to produce, relatively durable, light, and easily adapted to various shapes and applications, plastics found numerous functions, from garbage bags to spaceships. But what was initially their big advantage, now became a major drawback. Due to the misleading of plastic waste, they became the continuous contamination of the environment, possessing a threat to all living organisms. Despite numerous educational campaigns on the implications of plastic waste, it still ends up in nature in large quantities. Moreover, this plastic does not remain on its first disposal site but is washed into the rivers and oceans where tiny plastic particles, called microplastics, enter food chains. According to the reports, people might ingest up to more than 100,000 microplastic specks each day. Notwithstanding, the plastic demand does not slow down. The global plastic market size was valued at USD 593.00 billion in 2021 and is expected to continue with an annual growth rate of 3.7% from 2022 to 2030. Much of this newly produced plastic will reach marine and freshwater, and undergo fragmentation under UV radiation, winds, oxidizing agents, and physical abrasion reaching diameters less than 5 mm, and creating mass called microplastic or even smaller, nanoplastic ($< 1\mu m$). The threat of that small particles is that they can easily cross cell membranes or even the blood-brain barrier and they can act as carriers for various chemicals such as heavy metals, polychlorinated biphenyls (PCBs), and pesticides. This causes a threat of prolonged release, higher durability in the environment as well as higher migration risk of these toxins. Therefore, analysis of microplastic fate in the environment is of the highest importance to our well-being.

The biggest issue with the environmental samples preparation for microplastic analysis is that they require different approaches, depending on the sample origin and complexity of the original matrix. The least demanding are drinking water samples, which have to be analyzed for microplastic contamination in California since 2021. The drinking water sample preparation protocol consists of several sample sieving and vacuum filtration. Then the samples should be microscopically examined prior to spectroscopic analysis. Based on the estimations the cost of a single sample according to the water board's standardized testing method will reach between USD 1,000 and USD 2,000. It has to be underlined that, the sample preparation becomes more complicated, time-consuming, and expensive for complex matrices such as river water, sediments, wastewater, and biowaste. For these samples, additional steps of organic matter removal are required, which involve advanced sample oxidation and enzymatic treatment to remove organic contaminants.

Thus, the main objective of the presented project is the fabrication of advanced multifunctional bioactive membranes, their thorough characterization, and application of the formed biomembranes in the process of environmental samples preparation for microplastic pollution analysis to reduce procedure time, cost, and the number of steps. The planned research is of highly cognitive and innovative aspects as the results expand the existing state of knowledge and allow to evaluate of novel, efficient protocols for the synthesis of bioactive membranes and their application in environmental samples preparation for microplastic analysis. What is even more important, the obtained data should facilitate the development of new, eco-friendly solutions for simplified, efficient, and more affordable sample preparation protocols for hazardous pollutants analysis, such as microplastic particles, in water solutions.