Recent estimates indicate that in 2015 humans had produced 4,9 billion tonnes of different plastics. Given the growing market demand for plastic products, the production is expected to exceed 12 billions tonnes till 2050. Plastic products contaminating environment slowly breakdown to smaller and smaller particles, finally to form micro- and nanoplastics (MNPlastics). MNPlastics are tiny plastic particles of different shape and size, which can be found in air, soil, water, but also in biota and humans. According to initial definition MNPlastics are below 5 mm in size and come from a variety of sources, including home-use products and textiles, agriculture, industry, waste, litter and others. A subset of microplastic smaller than 1 μm is often referred to as nanoplastics. Majority of produced plastic vaste that occur most frequently in the environment is hardly degradable thermoplastic polymers, such as polyethylene, polypropylene, polystyrene, polyvinylchloride, polyethyleneterephtalate and polyurethane. Moreover, some newly-developed, biodegradable plastics (e.g. polylactide acid) may contribute to the microplastic debris, as they are not fully degraded under natural conditions. Despite the MNPlastics are wide spread pollutants of an environment our knowledge about the MNPlastics toxicity is very limited.

However, increasing body of evidence suggests that MNPlastics might be a threat for aquatic biota. Observations of aquatic wildlife in a range of habitats have revealed that microplastic is taken up by animals of all habitants, including the sea surface, water column, benthos, estuaries, beaches and aquaculture facilities. Over 220 different species have been found to ingest microplastic debris in natural conditions. In wild aquatic organisms, MNPlastics have been observed in the gastrointestinal tract and to limited extent in gills. Adverse effects of MNPlastics consumtion have been observed in aquatic organisms under laboratory conditions, but literature lacks epidemiological studies, which would examine the effects of MNPlastics on the human health. There is also a lack of standardized methods that would allow for robust and reliable investigations on MNPlastics toxicity, both in vitro and in vivo.

Therefore, the primary objective of this project is to elucidate effects of model MNPlastics and MNPlastic derived from commercially available tea bags on functions of guts and brain. The guts are the main entry pathway of MNPlastic to human organisms, whereas the brain is one of the main target organs. Both organs communicate through so call gut-brain axis, neuro-hormonal signaling pathway, additionally modulated by gut microbiota. The gut-brain axis plays an important role in maintaining a physiological functions of brain. The gut microbiome affects brain functions through the immunological and hormone dependent mechanisms.

Second primary objective of this project is develop robust and reliable in vitro models for MNPlastic toxicity studies that might replace animal use in the future. At the moment the best seems to be 2D/3D multitissue cultures.. The response from in vitro 3D multitissue cultures will be compared with response of rat model to reveal how reliable are in vitro models.

The project has a purely cognitive character. Its results will prove valuable in the context of public health and toxicology. The project will serve in order to enrich the knowledge base in these areas. Proposed research may, in the future, be extended to other MNPlastics to gain more information, and the results will be used for further detailed analysis. This analysis will facilitate understanding of the mechanisms of MNPlastics action on humans and will help identify the potential risks that MNPlastics pose to human health and life. The current state of knowledge does not allow to draw clear conclusions about the impact of MNPlastics on the human body. Increasing abundance of MNPlastics in everyday life and enivironment, demands to carry out extensive research in the field, since there is increasing body of evidence of possible harmful effects of MNPlastics. This project will help to determine the impact of MNPlastics on brain functions and its potential contribution in the development of mental diseases, but also infertility, a problem that touches increase number of people. It will estimate the risks of exposure to MNPlastics designed at the molecular level may, in turn, lead to the introduction of appropriate regulations at the international level.