Due to their ability to photosynthesise, plants are the primary biomass and oxygen producers, both essential for life on the Earth. The increasing degradation of our natural environment and global climate changes pose a serious threat for the plant productivity and in the longer term for the existence of the mankind. Fortunately, plants have diverse and efficient mechanisms of adaptation to various adverse environmental conditions, which are enhanced by continuous and intimate interactions with beneficial microorganisms collectively known as a plant microbiome. It consists of countless bacteria that dwell in the narrow region of soil around plant roots and are called rhizospheric microorganisms. Others live inside plant tissues and are called endophytic microorganisms. Especially the latter ones are of particular importance, due to their even closer interactions with a plant host and the possibility of being transferred through seeds to the plant progeny. Such endophytic microorganisms can enhance plant growth and confer stress tolerance but we have only begun to study and understand the importance of such interactions. The endophytic bacteria are capable to colonise various parts of a host plant, such as roots, leaves, stems, flowers and seeds. Nonetheless, the roots are the organs most abundant in these bacteria, both in terms of their number and diversity. The successful colonisation requires the bacteria to communicate with their host through the "language" made of various proteins and other molecules but also to withstand or modify often challenging conditions of the plant interior. The plant growth promotional effect of endophytic bacteria could be the result of stimulating the plant immune system to confer tolerance to conditions which would otherwise reduce growth. These processes could act through the promotion of phytohormone production by the endophytes. Another possibility is that endophytic bacteria help to mobilise nutrients otherwise not available for plants, for example phosphorus and iron. The diverse bacterial metabolism enables also the mineralisation of pollutants that could otherwise hinder plant growth and enter the food chain. Thus, endophytic bacteria can be used as effective biofertilisers and to clean-up the soil that is contaminated by for example oil and heavy metals. However, despite promising results under controlled conditions, field tests showed to be less successful due to considerable inconsistency in their outcomes. Therefore, further research is urgently needed to better understand key features of these plant-bacterial interactions.

The aim of this project is to elucidate genetic features required for establishment of prosperous plant-bacteria interactions. To make such a study, we will use a plant species called *Brachypodium distachyon*, which (as for example, mouse, fruit fly and zebra fish) is a model organism that is relevant for cereals, such as wheat, barley, rye and many other economically and/or ecologically important grasses. The endophytic strain with the most extensive growth promotion abilities will be subjected to whole genome sequencing that will help in elucidation of genetic features determining such beneficial properties. We will also study the changes in the plant metabolite composition and the simultaneous analysis of gene expression both in the plants and in their endophytic bacteria. This will allow us the identification of differentially expressed genes within which key features governing plant-bacteria interactions will be defined. In order to confirm their involvement, plants with non-functional versions of these key genes will be created using gene editing. Finally, the impact of mutation on endophyte-plant interaction will be characterised through microscopic observations and changes in plant metabolism (the "metabolome").

Extending our knowledge of the complex and to a large extent unknown genetic elements governing endophyte bacteria-host plant interactions should facilitate in the future development of more effective and successful ways of using these important microorganisms to enhance plant growth, to increase their resistance to various stressors, and in the result to increase their yield in agriculture.