Plants produce a number of specialized metabolites to communicate with their environment and to defend against their foes including herbivores and microbial pathogens. The phylogenetic occurrence of individual plant specialized products is frequently restricted to particular lineages, such as a family or genus, which suggests rapid evolution of the respective biosynthetic pathways. Many of the specialized metabolites possess interesting chemical and biological activates, which make these compounds attractive for humans. For instance plants from the cabbage family, which includes oilseed rape and numerous vegetables that are cultivated worldwide, have capacity to produce unique thioglucosides known as glucosinolates. In response to the environmental stresses, these compounds can be rapidly activated to bioactive products that deter herbivorous insects and contribute to the protection of plant tissue from colonization with different pathogens. Thus, the respective end products of this activation are of interest because of their insecticidal and antimicrobial activities. Moreover, it has been shown that presence of glucosinolates in human diet reduces risk of certain cancer forms. Overall, glucosinolates constitute a group of metabolites with useful properties and therefore became of research interest.

During this project we would like to focus on enzymes involved in modification of tryptophan-derived indole glucosinolates and subsequent activation of these compounds for antifungal defense. Both, modification and activation are indispensable for the function of indole glucosinolates in plant immunity. To these end we would like to characterize the residues of these enzymes that are important for their specific functions. The few investigated enzymes will include phytochelatin synthase, an interesting protein with an established function in plant tolerance to heavy metal ions that in the cabbage plant family most likely evolved a novel additional function by being recruited into the pathogen-triggered activation of indole glucosinolates. In addition to the research on these enzymes we would like to identify the yet unknown bioactive end products of the pathogen-triggered pathway for indole glucosinolate activation.

Obtained in this project results will shed some light on the molecular basis of the activity of enzymes involved in indole glucosinolate modification. This in turn could support rational design of novel enzyme variants that could eventually mediate novel modifications of these compounds. Subsequent metabolic engineering with such enzymes may deliver cabbage family plants with new indole glucosinolate types that can be activated to end products with novel interesting biological activities. Our study will also reveal molecular determinants of the novel function of phytochelatin synthase in plant immunity. This will not only deepen our knowledge on glucosinolate activation mechanisms, but also should contribute to the research on multifunctional proteins in general. Identification of the end products of the indole glucosinolate activation pathway will broaden our knowledge on the complexity of glucosinolate activation products. In addition, as some of these products may possess antifungal activity they could be used as templates for rational design of novel fungicides. Finally, knowledge gained in this project can become of significance for future crop cultivation and protection strategies. For instance, it may facilitate rational breeding or genetic design of plants with specialized metabolite profiles optimal for plant immunity.