Universität Basel

Research Project

Perception of MAMPs and DAMPs by PRRs in plants.

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Project title Perception of MAMPs and DAMPs by PRRs in plants.
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Plants are exposed to myriads of potential microbial pathogens, but the world is still green, because plants possess an efficient innate immune system to detect and ward off potentially dangerous microbes. How does the plant's innate immune system work? In the course of my current project of the Swiss National Science Foundation (2004-2009), our studies firmly established the importance of the perception of **microbe-associated molecular patterns (MAMPs)** by **pattern recognition receptors (PRRs)** for innate immunity in plants, and caused a renaissance of the "elicitor concept", as we summarized in a recent review (Boller and Felix, Annual Review of Plant Biology, 2009). In fact, the two MAMP/PRR pairs of Arabidopsis that we discovered and analyzed, initially bacterial flagellin and the plant's leucine-rich-repeat receptor kinase (LRR-RK) FLS2, and subsequently bacterial elongation factor EF-Tu and the plant's LRR-RK EFR, have now become widely-used models to study the plants' innate immune system.

In the proposal for the next three years (2009-2012), we want to continue and expand promising aspects of our current work. Our first focus will be on structure-function relationships in the interaction between the MAMP signals and the MAMP binding sites on the LRR-domains of the PRRs. Here, we have advanced particularly well during recent months, and we want to use the current knowledge to define the structural requirements of MAMP ligands to act as functional stimuli when bound to their receptors.

We also want to address a question that has thus far received little attention in plant innate immunity but seems to become an emerging field in biomedical research, namely innate-immunity stimulation through **"damage-associated molecular patterns" (DAMPs)**. DAMPs are molecules (or characteristic "epitopes") that are released from within the cells, or from the intact cell wall, into the extracellular space, due to damage caused by an invading pathogen, and then are perceived by PRRs on neighboring cells. In this respect, we want to take up fascinating work by the group of Clarence A. Ryan, who has described AtPep1 and PEPR1 as a DAMP/PRR pair in Arabidopsis, shortly before his untimely death in 2007. AtPep1 is a 23 amino acid peptide derived from a small cytoplasmic protein, PROPEP1. AtPep1 provokes a type of innate immunity response when exogenously applied to Arabidopsis cells, in subnanomolar concentrations. The receptor of AtPep1 appears to be a LRR-RK similar to FLS2 and EFR, named PEPR1. We want to compare the AtPep1/PEPR1 response, as a model of a DAMP/PRR interaction, with the flagellin/FLS2 and the EF-Tu/EFR response, as models of the MAMP/PRR interaction. Do these signaling pathways converge at some point, or do they act independently? Are the ligand-binding processes similar, and can the extracellular domains of the receptors be "swapped" to obtain functional chimeric receptors?

DAMP signaling might be systemic, spreading throughout the plant from the initially locally confined area of signal perception. In this respect, we want to test, for both MAMPs and DAMPs, whether they can

provoke a systemic response upon local application, through unknown second messengers, or whether they can be transported themselves through the plant's vascular system and function as signals at a distant systemic site.

Finally, we want to make use of our MAMP/PRR and DAMP/PRR models to further investigate the ways successful pathogens circumvent this first line of defense. We want to focus on bacterial effectors that interfere with signaling at the earliest stages, ideally at the level of the receptor complexes themselves, as recently described for two classic bacterial effectors, AvrPto and AvrPtoB.

We hope that the research outlined in the present project, in conjunction with studies on BAK1 currently performed by Delphine Chinchilla in our institute, with her separate independent SNF project, and also in conjunction with the planned studies by Misha Pooggin, who has just submitted an SNF proposal on the role of innate immunity in the plants' defense against viruses, will further enrich and expand our knowledge of plant innate immunity.

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