Plants recognise pathogenic and beneficial microorganisms

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Plant roots are surrounded by thousands of bacteria and fungi living in the soil and on the root surface. To survive in this diverse environment, plants employ sophisticated detection systems to distinguish pathogenic microorganisms from beneficial microorganisms.

Here the so-called chitin molecules from microorganisms, along with modified versions, play an important role as they are detected by the plant surveillance system. Legumes, for example, build a defence against pathogenic microorganisms in response to simple chitin molecules.

However, when the plant detects a specific modified chitin molecule (called a Nod factor) that is secreted from the *rhizobium* soil bacteria, formation of new organs in the form of "root nodules" occurs. *Rhizobium* bacteria are allowed to enter and colonise in these symbiotic organs, and they ultimately produce nitrogen for the plant.

The plants' detection of ligands – such as chitin and modified Nod factors – takes place through protein receptors that are localised on the surface of cells. Research at the Centre for Carbohydrate Recognition and Signalling (CARB) has now shown that ligand recognition through direct Nod factor binding is a key step in the receptor-mediated signal transduction that leads to root nodule development in legumes.

High-affinity binding was observed in the nano-molar range, comparable to the biologically relevant concentrations where Nod factor has in vivo activity. In contrast to this, simple chitin molecules bind to the receptors

with low affinity. Structure-dependent ligand specificity and ligands binding affinities at different receptors may therefore determine which response mechanism is activated in plants exposed to different microbes or microbial communities in the environment.

Interdisciplinary approaches combining advanced biochemistry, chemoselective chemistry and microbial genetics made it possible to investigate the molecular mechanisms involved in distinguishing between Nod factor molecules secreted from rhizobia and chitin secreted by pathogenic microorganisms.

The challenging task of purifying plant receptor proteins, which are present in very low amounts in roots of the model legume *Lotus japonicus*, was successfully accomplished by expressing the receptors in heterologeous plant-based systems and purifying them from membrane fractions.

Another challenge was the establishment of binding assays with the carbohydrate ligands. Nod factor labelling and Nod factor immobilisation facilitated this, following application of chemoselective chemistry.

The researchers behind the results that have just been published in the international journal *PNAS* are affiliated with the Danish National Research Foundation's Centre for Carbohydrate Recognition and Signalling at the Department of Molecular Biology and Genetics, Aarhus University (Denmark), Department of Chemistry, University of Copenhagen (Denmark) and Department of Microbiology and Immunology, University of Otago (New Zealand).

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