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Amino-acid cycling drives nitrogen fixation

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About 65% of the biosphere's available nitrogen is provided by the reduction of atmospheric N₂ to ammonium. Most of this is achieved by symbiotic nitrogen fixation, carried out in specialized plant organs called nodules. Their formation is induced on leguminous plants by bacteria belonging to the family *Rhizobiaceae*. It has been thought that this symbiotic relationship is sustained by the plant providing the bacteria with sources of carbon and energy in return for ammonium. In the April 17 *Nature*, Ludwig and colleagues from *Reading University, UK* show that the interaction is more complex, with plants providing amino acids to the bacterioids. This allows the shutdown of ammonium assimilation, and bacterioids cycle amino acids back to the plants for asparagines synthesis.

Ludwig *et al.* examined amino-acid cycling in pea bacterioids by the mutation of two ABC-type amino-acid transporters with broad specificity - *aap* and *bra*. Single mutants resulted in a 40-70% reduction in rates of amino-acid uptake by pea nodules. No difference in pea growth was observed in the presence of the mutant bacterioids, however. A double *aap bra* mutant was also capable of amino-acid synthesis, but phenotypic observations suggested that the plants were unable to fix nitrogen. Further analysis established that the plants were capable of reducing nitrogen in the presence of the *aap bra* mutants, but that the plants could not acquire ammonium. The authors propose that plants provide bacterioids with amino acids via Aap and/or Bra; in turn, bacterioids can shut down ammonium assimilation. To obtain amino acids the bacterioids secrete ammonium to the plant - thus allowing amino-acid synthesis to occur.

The authors conclude that "the interaction between the symbiotic partners is far more complex than hitherto realized: each has evolved a complete metabolic dependence on the other."

References

1. Carbon and nitrogen metabolism in Rhizobium.
2. *Nature*, [<http://www.nature.com>]
3. Reading University, [<http://www.rdg.ac.uk>]