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The Endosymbiotic relationship of Leguminosae (Fabaceae) and Rhizobium

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College of Southern Nevada, INBRE PIPELINE PROGRAM
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INTRODUCTION
This project will look at The Endosymbiotic Relationship of Leguminosae (Fabaceae) and Rhizobium. Endosymbiosis Theory is the concept that mitochondria and chloroplasts are the result of years of evolution initiated by the endocytosis, (the process by which cells absorb material through their cell membrane) of bacteria and algae which, instead of becoming digested, became symbiotic. The mitochondria of eukaryotes evolved from aerobic bacteria, probably rickettsias, living within their host cell and the chloroplasts from cyanobacteria, also known as blue-green algae. Endosymbiosis is a type of symbiosis in which one organism lives inside the body of another and both function as a single organism, comes from a Greek word meaning "inside," "with," and "living." Endosymbiosis in biology is a subdivision of the more general concept, symbiosis, which refers to living beings of different species living together for most of the life history of a member of at least one of those species.

*Rickettsia bacteria cause diseases such as typhus and Rocky Mt Spotted Fever.*

LEGUMINOSAE & RHIZOBIUM
Nitrogen fixation by legumes is a partnership between a bacterium and a plant. Legume nitrogen fixation starts with the formation of a nodule. A common soil bacterium, *Rhizobium,* invades the root and multiplies within the cortex cells. Rhizobium enters the roots of the legumes either through root hair or directly at the point of emergence of lateral roots. Curling or controlled growth and branching of root hairs is the first visible plant response to Rhizobium. Although, legume nodules generally seem to harbor only one strain of Rhizobium, a given root can certainly form nodules with more than one strain.

It is reported that Rhizobium strains capable of infecting a legume releases a specific polysaccharides that induces more pectolytic activity by the root that accounts for cross inoculation specificities. It is not known how Rhizobium initiates the infection thread. Some suggested mechanical rupture with Rhizobium entering a break in root hair wall. Rhizobium may also get trapped within the fold of growing deformed hair. The infection thread enters and penetrates the context of the root from cell to cell. Finally the thread bursts and liberates the rod shaped bacteria into critical cells. This cell divides to form nodular tissue in which bacteria divide and multiply. Eventually, a demarcation develops, a centrally located bacteria containing, the tissue called the bacterial zone is marked out in the nodule from the surrounding bacteria-free tissue called the nodule cortex. The nodular tissue grown in a size, pushes itself through the root and then emerges as an appendage on the root system. Its size and shape depends on the species and legume.

In the field, small nodules can be seen 2-3 weeks after the planting, depending on the legume species and germination conditions. When nodules are young and not yet fixing nitrogen, they are usually white and gray inside. As nodules grow in size, they gradually turn pink or reddish in color, indicating that nitrogen fixation has started. The pink or red color is caused by leghemoglobin (similar to hemoglobin in blood) that controls oxygen flow to the bacteria.

In return for the fixed nitrogen that they provide, the rhizobia are provided shelter inside of the plant's nodules and some of the carbon substrates and micronutrients that they need to generate energy and key metabolites for the cellular processes that sustain life.

NITROGEN CYCLE
The process of biological nitrogen fixation was discovered by the Dutch microbiologist Martinus Beijerinck. Nitrogen (N) is an essential constituent of protein, DNA, RNA, and chlorophyll. N is the most abundant gas in the atmosphere, but it must be fixed or converted into a usable form.

**Nitrogen Fixation Methods:**
1) High energy fixation- a small amount of atmospheric nitrogen is fixed by lightening. The high energy combines N andH2O resulting in ammonia (NH3) and nitrates (NO3). These forms are carried to Earth in precipitation.
2) Biological fixation: achieves 90% of the nitrogen fixation. Atmospheric nitrogen (N2) is split and combined with hydrogen (H) atoms to form ammonia (NH3).

**Who performs nitrogen fixation?**
* symbiotic bacteria (eg. Rhizobium spp.) living in association with leguminous ( plants in the pea family), and root
* noduled non-leguminous plants (eg. Alnus spp.).
* free-living anaerobic bacteria
* blue-green algae (cyanobacteria)

References
[Endosymbiosis Lynn Margulis.mht](http://www.soils.umn.edu/academics/classes/soil2125/doc/s9chap2.htm)

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