

# Agrobacterium

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**Agrobacterium** is a genus of Gram-negative bacteria established by H. J. Conn that uses horizontal gene transfer to cause tumors in plants. *Agrobacterium tumefaciens* is the most commonly studied species in this genus. *Agrobacterium* is well known for its ability to transfer DNA between itself and plants, and for this reason it has become an important tool for genetic engineering.

The *Agrobacterium* genus is quite heterogeneous. Recent taxonomic studies have reclassified all of the *Agrobacterium* species into new genera, such as *Ruegeria*, *Pseudorhodobacter* and *Stappia*, but most species have been reclassified as *Rhizobium* species.

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## Plant pathogen



The large growths on these roots are galls induced by *Agrobacterium* sp.

*A. tumefaciens* causes crown-gall disease in plants. The disease is characterised by a tumour-like growth or gall on the infected plant, often at the junction between the root and the shoot. Tumors are incited by the conjugative transfer of a DNA segment (T-DNA) from the bacterial tumour-inducing (Ti) plasmid. The closely related species, *A. rhizogenes*, induces root tumors, and carries the distinct Ri (root-inducing) plasmid. Although the taxonomy of *Agrobacterium* is currently under revision it can be generalised that 3 biovars exist within the genus, *A. tumefaciens*, *A. rhizogenes*, and *A. vitis*. Strains within *A. tumefaciens* and *A. rhizogenes* are known to be able to

harbour either a Ti or Ri-plasmid, whilst strains of *A. vitis*, generally restricted to grapevines, can harbour a Ti-plasmid. Non-*Agrobacterium* strains have been isolated from environmental samples which harbour a Ri-plasmid whilst laboratory studies have shown that non-*Agrobacterium* strains can also harbour a Ti-plasmid. Many environmental strains of *Agrobacterium* possess neither a Ti nor Ri-plasmid. These strains are of course avirulent.

The plasmid T-DNA is integrated semi-randomly into the genome of the host cell,<sup>[1]</sup> and the tumor morphology genes on the T-DNA are expressed, causing the formation of a gall. The T-DNA carries genes for the biosynthetic enzymes for the production of unusual amino acids, typically octopine or nopaline. It also carries genes for the biosynthesis of the plant hormones, auxin and cytokinins), and for the biosynthesis of opines, providing a carbon and nitrogen source for the bacteria that most other micro-organisms can't use, giving *Agrobacterium* a selective advantage.<sup>[2]</sup> By altering the hormone balance in the plant cell, the division of those cells cannot be controlled by the plant, and tumors form. The ratio of auxin to cytokinin produced by the tumor genes determines the morphology of the tumor (root-like, disorganized or shoot-like).

## Agrobacterium in humans

Although generally seen as an infection in plants, *Agrobacterium* can be responsible for opportunistic infections in humans with weakened immune systems,<sup>[3][4]</sup> but has not been shown to be a primary pathogen in otherwise healthy individuals. One of the earliest associations of human disease caused by *Agrobacterium radiobacter* was reported by Dr. J. R. Cain in Scotland (1988).<sup>[5]</sup> A later study suggested that *Agrobacterium* attaches to and genetically

### Agrobacterium



#### Scientific classification

Kingdom: Bacteria  
 Phylum: Proteobacteria  
 Class: Alpha Proteobacteria  
 Order: Rhizobiales  
 Family: Rhizobiaceae  
 Genus: ***Agrobacterium***

#### Species

- *Agrobacterium radiobacter*
- *Agrobacterium rhizogenes*
- *Agrobacterium rubi*
- *Agrobacterium tumefaciens*

transforms several types of human cells by integrating its T-DNA into the human cell genome. The study was conducted using cultured human tissue and did not draw any conclusions regarding related biological activity in nature.<sup>[6]</sup>

## Uses in biotechnology

*See also: horizontal gene transfer*

The ability of *Agrobacterium* to transfer genes to plants and fungi is used in biotechnology, in particular, genetic engineering for plant improvement. A modified Ti or Ri plasmid can be used. The plasmid is 'disarmed' by deletion of the tumor inducing genes; the only essential parts of the T-DNA are its two small (25 base pair) border repeats, at least one of which is needed for plant transformation. Marc Van Montagu and Jozef Schell at the University of Ghent (Belgium) discovered the gene transfer mechanism between *Agrobacterium* and plants, which resulted in the development of methods to alter *Agrobacterium* into an efficient delivery system for gene engineering in plants.<sup>[7][8]</sup> A team of researchers led by Dr Mary-Dell Chilton were the first to demonstrate that the virulence genes could be removed without adversely affecting the ability of *Agrobacterium* to insert its own DNA into the plant genome (1983).

The genes to be introduced into the plant are cloned into a plant transformation vector that contains the T-DNA region of the disarmed plasmid, together with a selectable marker (such as antibiotic resistance) to enable selection for plants that have been successfully transformed. Plants are grown on media containing antibiotic following transformation, and those that do not have the T-DNA integrated into their genome will die. An alternative method is agroinfiltration.

Transformation with *Agrobacterium* can be achieved in two ways. Protoplasts, or leaf-discs can be incubated with the *Agrobacterium* and whole plants regenerated using plant tissue culture. A common transformation protocol for *Arabidopsis* is the floral-dip method: the flowers are dipped in an *Agrobacterium* culture, and the bacterium transforms the germline cells that make the female gametes. The seeds can then be screened for antibiotic resistance (or another marker of interest), and plants that have not integrated the plasmid DNA will die.

*Agrobacterium* does not infect all plant species, but there are several other effective techniques for plant transformation including the gene gun.

*Agrobacterium* is listed as being the original source of genetic material that was transferred to these USA GMOs:<sup>[9]</sup>

- Soybean
- Cotton
- Corn
- Sugar Beet
- Alfalfa
- Wheat
- Rapeseed Oil (Canola)
- Creeping bentgrass (for animal feed)
- Rice (Golden Rice)

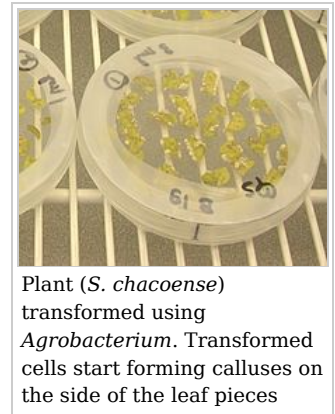
## Genomics

The sequencing of the genomes of several species of *Agrobacterium* has permitted the study of the evolutionary history of these organisms and has provided information on the genes and systems involved in pathogenesis, biological control and symbiosis. One important finding is the possibility that chromosomes are evolving from plasmids in many of these bacteria. Another discovery is that the diverse chromosomal structures in this group appear to be capable of supporting both symbiotic and pathogenic lifestyles. The availability of the genome sequences of *Agrobacterium* species will continue to increase, resulting in substantial insights into the function and evolutionary history of this group of plant-associated microbes.<sup>[10]</sup>

## See also

- Agroinfiltration
- Marc Van Montagu

## References



Plant (*S. chacoense*) transformed using *Agrobacterium*. Transformed cells start forming calluses on the side of the leaf pieces

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## External links

- Current taxonomy of *Agrobacterium* species, and new *Rhizobium* names (http://www.rhizobia.co.nz/taxonomy/not-rhizobia)
- Agrobacteria is used as gene ferry (http://www.gmo-safety.eu/basic-info/294.soil-bacterium-gene-transporter.html) - Plant transformation with *Agrobacterium*]

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