Crown gall disease is caused by the bacterium *Rhizobium radiobacter* (previously *Agrobacterium tumefaciens*). *R. radiobacter* infects a broad range of over 1000 different plant species. The disease is a particularly serious problem for grape vines, walnuts, apple, raspberry and other fruit and nut trees.

This DNA forces the plant to produce excess growth hormones, causing plant cells to grow uncontrollably and tumours called galls to form. These galls are full of bacteria and act as ‘food factories’. The plant is also engineered by bacterial DNA to produce sugars, which only the bacteria can make use of.

When plants are injured, sugars leak out from the wound site into the surrounding soil. *R. radiobacter* bacteria living in the soil ‘smell’ these sugars and swim towards the plant wound using tail-like structures called flagella, as shown in Image 3.

Galls begin to form a few days after *R. radiobacter* bacteria enter the plant. Galls start off as small, soft, white lumps on the stems and roots. As the tumours grow, they become woody and hard as the plant cells die.

*R. radiobacter* then enters the plant through the wound and releases a small loop of DNA, which gets incorporated into the plant’s own DNA.
How do plants die?

Galls clog up the plant’s water transport system and can block up to 80% of water uptake. Gall production also uses a lot of the plant’s energy. These stunt plant growth, production of fruit and nuts and cause leaves to turn yellow. Galls can eventually result in plant death.

How does it spread and survive?

Insects, bacteria and fungi often break down the galls, releasing more *R. radiobacter* back into the soil.

The *R. radiobacter* bacteria are washed onto neighbouring fields via rainwater, allowing the disease to spread locally. Moving infected plants to healthy areas can spread the disease across much wider distances.

The bacterium can survive in soil for at least two years, by feeding off dead plant material, all the time ready to infect the next susceptible plant that gets injured.

What can be done to control the disease?

Unfortunately, chemical sprays do not kill *R. radiobacter* galls. Instead, it’s best to breed and grow plants that are resistant to infection. When an infected plant is spotted, it should be destroyed to prevent spread to healthy plants.

Growers should disinfect their equipment to stop bacteria spreading between plants.

Scientist’s best friend!

The discovery that *R. radiobacter* can transfer DNA to plants has caused a scientific revolution! Scientists are able to use the bacterium to genetically modify plants (Image 8.)

First, bacteria are disarmed (by removing a specific piece of DNA that causes tumours) and then new DNA is added that encodes a plant trait of interest. When these modified bacteria infect the plant, the plant takes up the DNA with the beneficial new trait.

There are many examples of plants, which have been genetically modified (GM) using *R. radiobacter*. These include:

- GM soybean resistant to glyphosate herbicides.
- GM ‘Bt cotton’ plants containing genes encoding toxins, from the bacteria *Bacillus thuringiensis* (Bt). These toxins kill off specific insect pests.
- GM ‘golden rice’, which contains higher levels of the vitamin A precursor (beta-carotene). It’s hoped that ‘golden rice’ will help combat vitamin A deficiency for the millions of people who depend on rice as their staple food crop.

Questions

1. Which human disease do plant galls remind you of?
2. How are *R. radiobacter* bacteria well suited to infecting plants?

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