MicroRogue: Agro (*Agrobacterium tumefaciens*)

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Agro tumors on the root of a plant.
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Claim to fame: cancer of plants

Plants, just like you and me, rely on hormones to carry out essential physiological functions. These hormones are tiny chemical signals that control how plants grow, develop, and even defend themselves against pests and pathogens. The general action of plant hormones shapes the definitive architecture of a plant, like the size and shape and the arrangement of leaves, stems and roots. When a plant's hormones get out of balance, they can cause parts of the plant to grow abnormally, forming galls or tumors. This excessive growth is often triggered by tiny invaders such as viruses, bacteria, or insects that disrupt the plant's normal growth patterns.

Agro cells binding to carrot cells. From Wikipedia Commons. File licensed under the CC BY-SA 3.0 license.

Agro: the most versatile plant carcinogen. In 1897, Fridiano Cavara published a groundbreaking study detailing the discovery of a bacterium that caused tumor-gall formation in grapevines at the Naples Botanical Gardens. He also demonstrated similar effects on young plants. Subsequent investigations identified *Agrobacterium tumefaciens* – Agro – as the causative agent of these galls. This soil bacterium enters plants through wounds, such as those caused by pruning or insect and nematode infestations. Once inside, Agro manipulates the plant's hormonal balance, causing the overproduction of plant hormones that stimulate uncontrolled cell growth. This leads to the formation of tumors that can vary widely in shape and color depending on the host species. In fact, Agro affects over eighty different families of herbaceous and woody plants, making it one of the most versatile plant carcinogens.

Tumor appearance and locations. Agro can cause tumors on the roots, stems, and even the aerial parts of plants, as they spread throughout the plant. Tumors are typically large and form in chains, a condition known as 'crown gall'. Crown gall gets its name from its characteristic location on the plant: the "crown" where the stem joins the root at the soil surface. This is the region where the bacterium Agro usually enters through small wounds and begins to form the tumor. However, unlike some cancers in animals, these tumors rarely kill the plant.

But how does Agro induce galls? This is an amazing story! Agro cleverly tricks the plant into working for it! It injects its own genetic instructions – a piece of DNA called T-DNA – into the plant's cells, forcing the plant to produce special nutrients called 'opines'. These opines serve as a gourmet feast for Agro, providing it with all the nourishment it needs to thrive. Essentially, the bacterium turns the plant into its own personal food factory, demonstrating the incredible ability of these tiny organisms to manipulate their hosts. The T-DNA also specifies production of the plant hormones that upset the normal control of plant cell growth and multiplication, causing disorganized plant tissue growth and the production of galls (https://archive.bio.ed.ac.uk/jdeacon/microbes/crown.htm).

The importance of Agro for us

From adversary to accomplice: Agro has the ability to inject its T-DNA into the plant chromosome and hence to change gene expression in infected cells. When this was discovered, clever scientists began to exploit this unique ability, using Agro as a genetic tool to introduce other, beneficial genes into plants. These genes specify production of natural insecticides, enhanced herbicide resistance, or increased nutritional value of the crops by boosting vitamin production, among other improvements. This was the beginning of genetic engineering of plants and revolutionized agriculture by increasing crop yields and nutritional value of foods, which is essential for feeding an ever-increasing world population. Thus, while Agro is the causative agent of crown gall disease, a significant plant cancer, it has also become a valuable ally in sustainable agriculture. This remarkable microorganism exemplifies the duality of nature, highlighting how even harmful organisms can be harnessed for beneficial purposes.

Agro is a mighty clever rogue but also a powerful tool for protecting and improving plant health and increasing crop yields to feed the growing world population