Section V
Microbes and plants: From nurture to torture

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The human demand for food cannot be met without microorganisms. Agriculture benefits from them as additives for improving nutrient uptake by crops, or in combating diseases and pests. Microbes can increase the yields of, for instance, maize and soybeans. By binding free nitrogen gas from the air, microorganisms living symbiotically in nodules on plant roots can provide fertilizers. The question is whether these symbiotic bacteria can be transferred to other crops, to make them similarly independent of industrial fertilizers.

Tumour on a plant, caused by *Agrobacterium tumefaciens*.

Microorganisms such as *Agrobacterium* can also be used as tools for genetically adapting plants. These bacteria can insert foreign DNA into plant cells. This causes tumours but also introduces new genetic traits. Currently, transgenic crops are being made and grown in this way for the production of varieties of rapeseed, soybeans, cotton, maize, rice, and wheat with resistance to insects, herbicides or viruses. This is being done mostly in the USA and Asia. In Europe, such crops are banned by legislation because of public resistance to genetic modification. However, some cultivated varieties of crops seem to have been naturally genetically modified by *Agrobacterium* species!

Soil is a superb source of microbial biodiversity. In one gram of soil, one can find about the same number of bacteria as there are people on earth: five to six billion! As well as bacteria, other microorganisms including cyanobacteria, actinomycetes, fungi, algae, and protozoa are abundant and viruses and bacteriophages are omnipresent. Mycorrhizae (Greek *mukès* meaning mushroom and *rhiza* for root) are fungi that form a symbiotic community with the roots of plants. The largest living creature is actually a fungus with a sub-soil diameter of several kilometres!

On a plant surface, one can find up to ten million bacteria per square centimetre as well as other microbes and epiphytes on the leaves and stems of plants. These microorganisms are vital for plants, especially the fungi that decompose organic matter. They not only recycle important compounds and elements, but also create humus and soil structure by excreting polysaccharides. They can promote plant growth and health by inducing resistance to less beneficial microorganisms. However, this is not philanthropy at work, there is often a symbiotic relationship between soil microbes and plant roots. Plants produce sugars during photosynthesis, and they excrete some as root exudates, feeding the soil bacteria.

The relationship between plants and microorganisms, is not always symbiotic. Disease-causing microbes have also evolved and the relationship can often be disastrous. Sometimes viral infections are attractive (for example coloured streaks on tulip flowers), but microbial infections can cause enormous problems, particularly because agriculture depends on monocultures. Thus, the failure of potato crops in Ireland in the middle of the nineteenth century was due to a fungal infection known as potato blight. It caused famine, killing around a million people, and forcing a similar number to emigrate to the New World.

Seventeenth century painting of the Semper Augustus, the most rare and valuable mosaic virus tulip during the Tulipomania. Artist unknown.