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**22. Compare and contrast CRISPR technology with transformation of plant tissues using *Agrobacterium*.**

In the transformation of plant cells by Agrobacterium, a type of bacteria, the desired DNA is transferred from the bacterium and integrated into the plant nuclear genome. The DNA is then integrated into the plant’s nuclear genome to be inherited by the next generation. This means that Agrobacterium is capable of stable transformation. However, Agrobacterium is also capable of transient transformation, in which the DNA is not integrated into the genome, but is still transcribed in order to produce the desirable trait. This technology, which uses Agrobacterium, is widely popular because it is relatively inexpensive and easy to perform.

The downsides of using Agrobacterium however, are that some plant species are unwilling to regenerate, and that a sterile environment is necessary for the process.

CRISPR instead uses bacteriophages to manipulate genetic material. When bacteria are invaded by a virus (e.g. bacteriophage), they incorporate virus genetic material into their own genome. This genome encodes to form a complex enzyme known as a CRISPR associated protein. The same process can be applied to other cells for other applications such as genetic disorders, cancers, and agriculture.

CRISPR technology is highly targeted and more accurate. This is because the bacteriophages target the cells’ immune system mechanism to target genetic sequences, while agrobacterium just introduce genetic material into the plant cell and wait until *some* cells stably incorporate them in their genome.

Typically CRISPR only removes and alters existing DNA sequences, and does not introduce new genetic material taken from elsewhere. This means CRISPR is a way to speed up natural evolution of traits that could have been selected for naturally. In contrast, the usage of Agrobacterium introduces genetic material that encode for useful traits from other species (e.g. encoding of Bt genes)

CRISPR is also cheaper and more accessible compared to traditional GMO technology.