The how and why on genetically modified plants

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It is safe to say that modifying crops and cereals on a genetic level is required to support the increase in population we are experiencing now. The need for sturdier and faster growing crops that yield more food with less area is growing stronger. Up until recently in the human time line, our crops developed by the use of plant breeding have been sufficient. With the steep rise in population growth during these last couple of decades, our need for food will soon exceeded the amount of food that our crops developed from plant breeding can produce. This is where modern genetics step in to lead the way forward. With it, we can engineer plants to give the abilities we need for that specific plant. Although necessary for future growth, genetically modified crops have gotten a bad reputation from certain media. Alleged reports about how harmful these crops are for the natural environment and diversity of species have circulated and gained support. Is there really such harm with using genetically altered plants? This article will dwell deeper in to this subject to show the how and why on genetically modified plants.

A genetically modified plant is a plant that has had its genome modified by introducing foreign DNA using different methods that incorporates the DNA into the plant's genome and grants the plant new features, for example resistance from a certain herbicide. By genetically modifying plants in this way, it is possible to make plants grow in areas where they usually would have trouble growing. For example, by making the plants more resistant to drought you can make the plants grow in areas where water is scarcer. Not all genetically modified plants are used in agriculture as quite a lot are used for research in plant morphology and function to deepen our knowledge about how plants work.

Genetically modified crops growing in a field.

How do you get genetically modified plants?

Today, there are many different ways to modify the genes of plants, the most common being the use of bacteria or by shooting the genetic material directly in to the nucleus of the plant cells. *Agrobacterium tumefaciens* is a soil-living bacterium that causes the disease crown gall which induces tumor growth. They accomplish that by introducing genes in to the plants that cause the plants themselves to generate tumors. These genes on

the other hand, can be altered to introduce genes of our own choice by removing the tumor inducing genes and inserting our desired genes, creating a gene construct called a vector. This works on a numerous of different plants, although not on cereals. That is a major problem due to the fact that cereals are one of our most grown sources of food. But even this problem has been solved by finding the tumor inducing genes from a highly aggressive strain of *A.tumefaciens* that can infect cereal crops and put those genes in the vector. Another bacteria that is commonly used is *Agrobacterium rhizogenes* which is a similar bacteria to *A.tumefaciens* but instead of causing tumorous growth it causes hairy root disease which make the plants grow an excessive amount of roots. The other common method of modifying plant genes is by shooting the selected genes directly in to the plant. This is a method called microparticle bombardment. It involves coating micrometer sized spherical bullets of gold or tungsten with the genes we wish to introduce and shooting them with high velocity into the nucleus or its surrounding fluids (plasma). This also works on a numerous of different plants and have proven to be a highly successful method to modify plant genes.

A PDS-1000/He device, commonly used for microparticle bombardment.

Other less common methods to introduce foreign genes into plant cells include penetrating the cell walls using needle-like whiskers made out of siliconcarbide and mixing it with the genes of choice, creating pores in the cell wall by electrocuting the cells or adding a chemical substance named polyethyleneglycole (PEG) which allows the DNA to enter the cells. It is also possible to inject the DNA directly into the nucleus of the cells but this method is time consuming and not very effective.

What can you do with genetically modified plants?

There are numerous applications for genetically modified plants. The most obvious one being in agricultural uses, that is for food. It is possible to modify plants so that they are highly tolerant against insects that graze on the plants which will result in higher yield. Herbicide resistance is also a common feat that is highly sought after.

Today, it is fully possible to make plants that can produce pharmaceutical products that are usable in medicine. Fully functional vaccines for numerous of diseases, like rabies and measles, have been grown in plants like tobacco and potato. Human antibodies is

also a possible pharmaceutical product that we could be growing on a big scale in the near future. The antibodies are common in medicine as both diagnostic tools and as therapeutic treatments. Other pharmaceuticals that have been produced by plants include growth hormones and other hormones, hemoglobin, collagen and hirudin (anticoagulate). The way to produce these products today are either by having bacteria or having animal cell cultures make them. This used to be enough, but the demand for such products are growing and it is needed to scale up the production. Plants could be a cheaper way of doing that. They can be grown on fields for large yield and they can easily be stored and transported which would increase the availability of them and reduce the cost dramatically.

A concern about plants like these is that they could potentially spread to fields where the same species are grown for food, mixing in pharmaceutical plants with the normal ones. This could lead to people ingesting unnecessary medicines or vaccines which might cause problems. One way to work around this is by making sure that the plants used for producing these pharmaceuticals are only plants that we normally do not eat, like tobacco. Other ways is to separate the fields by large distances to reduce the chance of pollen spreading to the food producing fields or to use sterile male plants that does not produce pollen at all.

What if the genes spread to other species?

One major concern with the use of transgenic crops is that the genes we have incorporated would spread to other organisms. While it is not possible that the genes spread to humans or other animals, it might be possible that bacteria are able incorporate the DNA into their own. Most transgenic plants are derived from using genetic fragments from bacteria or virus. These fragments usually contain some form of drug resistance gene which is used to select the successful transgenic plants from the non-successful. If such genes could be transferred to bacteria, it could cause an increase in antibiotic resistance which could be a severe problem. It turns out though, that the bacteria are unable to do so for a numerous of reasons. Mainly the fact that bacteria have transfer genes for transferring DNA to their hosts and not receive it. But if they for some reason would take it, it would require that the plants have the transfer genes for transferring the genes back to the bacteria and there are no known plants that has those kind of genes.

Another common way for bacteria to get genes from outside sources is by bacteria phages, viruses that grow on bacteria. These will occasionally take some of the bacteria genes and incorporate them into their own and transfer it to the next bacteria they come across. However, this is highly unlikely to occur with genetically modified plants due to the fact that there are no known viruses that can infect both bacteria and plants. They are almost always very species specific.
It is still possible that bacteria might get the genes from the plants from an unknown way but it is most improbable. Even if bacteria would somehow get these genes, in order to use them they already need to have a homologue to the gene in order for it to be incorporated. If they already had a homologue to that antibiotic resistance gene it is more likely that they would get the genes by random mutations so the genes in the plants doesn't really increase the risk.