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## Genetic engineering: genetically modified organisms

Genetic engineering is a widely used biotechnological method to directly manipulate an organism's genome, and the Genetically modified organisms are the animal or plant that has been created through genetic engineering to increase the crop yield or to improve the nutrient value in animal. But what is the process of genetic engineering to make GMOs?

All the products of genetic engineering are basically using the same steps. The first step is in order to identify a desirable new trait, and it is also the hardest procedure because the discovery of the new trait often has a big uncertainty and may need thousands of experiments and trials to test. For example, a famous biotechnology company, Syngenta, wanted to search for a brand new kind of Golden Rice with an increased portion of pro-vitamin A (Powell. C. 2015).

The researchers at Syngenta first need to identify the gene sequence that produce this special kind of vitamin, and then screened a list of plants that they hypothesize will produce the nutrient of interest with that sequence (Paine, Jacqueline A.). With the combination of critical thinking and luck, they eventually found out that maize contained a gene that would make Golden Rice produce pro-vitamin A.

The second step is to Isolate the genetic trait of interest. Scientists use a method called Comparative analysis to compare the genomes of plants with the trait to genomes in the same species without the trait, and that helps to decode what part of an organism's genetic makeup contains the trait of interest (LaJeunesse.S, nd.). Monsanto company also developed a method known as seed chipping to accelerate this process which creates a genetic database for plants, and researchers then use this database to identify new traits of interest as well as to optimize the desirable traits in the organisms by selecting for the suitable genotypes based on plant phenotypes (How to make a GMO. 2015).

Step three is to insert the desired genetic trait into a new genome. Inserting the desired genetic trait into a new genome is very difficult because it's hard to change or rearrange the genomes due to their rigid structure. Thus, many biotech companies use gene guns that shoot metal particles with DNA into plant. Monsanto company invents another method called Agrobacterium tumefaciens (Powell. C. 2015). In this method, genetic trait is cut and pasted into a plasmid using enzymes, then insert the plasmid into bacteria that changes cells (How to make a GMO. 2015).

The final step is to grow the new GMO. After a genetic trait has been inserted into an

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organism's genome successfully, biotech companies usually invest large amount of money to keep the modified organism grow and replicate with its own newly genome (The science of GMOs, nd.).

During this process, the companies may use automated machines and climate-control chambers to track and calculate the optimum conditions for crops (Powell. C. 2015). So technically, the four key steps in genetic engineering are identifying a trait of interest, isolating the trait, inserting the trait into a desired organism, and then grow the organism

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