
How Does Genetic Modification Work?

The genetic modification and engineering of organic organisms (living things that naturally evolved instead of being scientifically made in a laboratory) is a newfound process that is risky and extremely complicated. The basic idea of genetic modification is to take a gene* from one organism and inject it into another. There are many different people and companies that have genetically modified and tweaked (slightly changed) animals and plants' cellular makeup, but here are the most famous examples explained (which I hope will help you understand genetic modification), in chronological order, from around 1971 to 2019:

Paul Berg, and the virus SV40

Paul Berg, born 1930 on June the 26th in Brooklyn, New York as the eldest of Harry and Sarah Berg's three children. His first big accomplishment of his career was in basic research into nucleic acids (the name for DNA and RNA) with Walter Gilbert and Frederick Sanger. The research managed to win him a third of a Nobel Prize for chemistry. But what I would call his greatest achievement was in the field of Genetic Modification and engineering, where he was the first person to genetically modify any living organism. He took the dangerous primate (monkey) virus SV40 and managed to attach its DNA* strands (using EcoRI) to those of the Lambda virus, making the first genetically altered living organism*. This act paved the way for Herbert Boyer and Stanley Cohen, who only a couple of months later created something quite similar.

Stanley Cohen, Herbert Boyer and pSC101

Stanley Cohen was a professor at Stanford University School of Medicine when he met Herbert Boyer, a professor at the University of California San Francisco, at a U.S - Japan meeting in Hawaii on plasmids (a small piece of DNA within a cell that can independently reproduce and is separate from Chromosomal* DNA) . After hearing each other's papers, they decided to work together to be the second group of people to genetically modify an organic living organism. Herbert Boyer was working at the time upon the successful introduction of the bacteria strangely called Lambda Virus (a virus that usually infects Escherichia coli, which kills and decomposes its host cell to inject its offspring) into the bacteria Escherichia coli, (which is now commonly called E. Coli, and lives in the intestines of animals. Most strains of it are harmless, but occasionally it can be deadly, like the type that produces Shiga, a horrible poison) while Stanley Cohen's work was focused upon gene expression (studying the information in a gene) in the bacteria "Virus" Lambda. The first success of their collaboration was to do with the plasmid pSC101, which when combined with the bacteria Escherichia coli, using the EcoRI technique (a technique which stagers DNA and rDNA ends instead of leaving them blunt, making it easier for cut DNA strands to reconnect) makes the E. Coli bacteria immune to tetracycline, a drug that treats "acne, cholera, brucellosis, plague, malaria, and syphilis." The second success of the career choice was when they used EcoRI to combine the previously plasmid pSC101 with one resistant to the drug kanamycin, which is used to treat severe bacterial infections and tuberculosis, and put the new plasmid combination inside the E. Coli cell. The point of the experiments was to explore and judge the wide options of this new technology, and to start and understanding of the techniques.

Rudolf Jaenisch and the mouse of leukemia

Rudolf Jaenisch was born in 1942 in Germany into a household of physicians and doctors. It was no surprise then when he applied and was accepted into medical school at the University of Munich, but it was a serious one when he decided to become part of the Max Planck Institute of Biochemistry in Martinsried, Germany while continuing at the medical school at the University of Munich. His big discovery was in 1974 while working with Beatrice Mintz when he found that DNA from other living organisms could be introduced into mouse embryos while they were still in an early stage. He demonstrated this by the injection of Retrovirus into mouse embryos and the DNA sequence of leukemia being found in both the parent and offspring of the embryos. This was the first genetic modification of a mammal ever to happen.

Humulin: Yeast or Bacteria?

Humulin (genetically modified insulin, which is a type of blood pressure reliever) was first produced by Panayotis Katsoyannis and Helmut Zahn (The two people who originally made Humulin were actually hundreds of miles apart when they created it, they just managed to create it simultaneously) in 1978. Insulin used to have to be extracted from cattle and pig pancreases, and if a patient was allergic to the treatment it could have dire consequences. There are two ways to produce genetically modified Insulin (A.K.A creating humulin): the first is to take yeast and use a naturally occurring protein as a host for the human Insulin creating gene. The second uses E. Coli in the same way as a transmitter for the human Insulin producing gene. The discovery of Humulin was revolutionary, and has created a billion dollar industry.

The Flavr Savr tomato! Hey, weird marketing!

The Flavr Savr tomato was originally created in 1994 by Calgene, a California crop firm that specializes in GM products. The Flavr Savr tomato went straight to the FDA after its creation and was the first genetically engineered edible crop approved by the Federal Food And Drug Administration. Its purpose was to stop the natural softening of a tomato and keep it firm through the journey to the supermarket. The usual way of trying to keep tomatoes firm is by picking them green and exposing them to Ethylene gas, which is a natural growth hormone. This method is unpredictable and can sacrifice the tomatoes flavor though, so Calgene's Flavr Savr tomato uses aminoglycoside 3'-phosphotransferase II to stop the enzyme Polygalacturonase, which breaks down a tomatoes thick fleshy walls and exposes it to mold and fungi. The method Calgene used was actually ineffective against the enzyme* Polygalacturonase though, and so unfortunately the products production was ceased in 1997.

A Salmon or and eel?

AquaAdvantage Salmon was created by AquaBounty technologies (a firm dedicated to genetically engineering seafood that is based in Canada) in 1998. The AquaAdvantage Salmon's purpose is to grow up to be bigger than regular Atlantic Salmon and grow faster than Atlantic Salmon. AquaBounty have achieved this amazing result by taking a growth-hormone gene from the rare Chinook Pacific Salmon and a promoter (a piece of DNA that acts like an "on" button) from Ocean Pout and injecting them into a regular Atlantic Salmon. Usually Atlantic

Salmon only grow during Spring and Summer, but the genetically engineered Salmon can grow during all seasons of the year, giving it a humongous advantage over regular Atlantic Salmon.

The Human baby made in an Alien way

The first genetically engineered and designed baby was created in 2018 by He Jiankui at the Southern University of Science and Technology in Shenzhen, China. He Jiankui and his graduate students were originally experimenting with non- viable embryos (embryos that cannot form babies) but decided to tread into uncharted territory by using active embryos for their research. The first genetically engineered human baby's (which are twins) were created so that it was impossible for either of them to catch HIV from their father (who had tested positive for it). This was done by disabling the gene CCR5, which is the gene that enables HIV to enter the body and infect immune system cells. Scientists have been trying to do exactly this for decades, but only with the recent creation of CRISPR- cas9 have they been able too.

DNA strands are like letters in an alphabet. DNA is sort of like your programing, and tells your body how to work and what to do. The DNA is coded in acids and thousands of bases, which are almost the exact opposite of acids (in a vinegar and baking soda experiment the vinegars acidic and the baking soda is a base, which causes it to react with the vinegar.) There are tons of individual strands within each cell, which are almost twisted

Sources

1. <http://www.crisprtx.com/gene-editing/crispr-cas9>
2. <https://greenamerica.org/gmo-inside>
3. <http://sciencegroup.org.uk/ifgene/history.htm>
4. <https://biologywise.com/history-of-genetic-engineering>
5. https://en.wikipedia.org/wiki/History_of_genetic_engineering
6. <https://www.genome.gov/about-genomics/teaching-tools/Genetic-Timeline>
7. <https://www.newscientist.com/article/dn9966-timeline-genetics/>
8. <https://www.genome.gov/Pages/Education/GeneticTimeline.pdf>
9. <https://sites.google.com/site/quinnlamb02/a-timeline-of-events>
10. <https://geneticliteracyproject.org/2017/07/18/biotechnology-timeline-humans-manipulating-genes-since-dawn-civilization/>
11. <https://www.timetoast.com/timelines/38652>
12. <https://newfoodeconomy.org/fda-aquabouty-gmo-salmon-seafood-restriction-market/>
13. <https://www.fda.gov/animal-veterinary/animals-intentional-genomic-alterations/aquadvantage-salmon-fact-sheet>
14. <https://www.fda.gov/animal-veterinary/animals-intentional-genomic-alterations/aquadvantage-salmon-fact-sheet>
15. <https://aquabouty.com/our-salmon/>
16. <https://aquabouty.com>
17. https://en.wikipedia.org/wiki/AquAdvantage_salmon
18. <https://www.sciencehistory.org/historical-profile/herbert-w-boyer-and-stanley-n-cohen>
19. https://en.wikipedia.org/wiki/Stanley_Norman_Cohen
20. http://www.genomenewsnetwork.org/resources/timeline/1973_Boyer.php
21. https://en.wikipedia.org/wiki/Herbert_Boyer
22. https://en.wikipedia.org/wiki/Paul_Berg

-
23. <https://www.nobelprize.org/prizes/chemistry/1980/berg/biographical/>
 24. <https://www.sciencehistory.org/historical-profile/paul-berg>
 25. <https://biology.mit.edu/profile/rudolf-jaenisch/>
 26. https://en.wikipedia.org/wiki/Rudolf_Jaenisch
 27. <https://www.pnas.org/content/101/39/13982>
 28. [https://en.wikipedia.org/wiki/Insulin_\(medication\)](https://en.wikipedia.org/wiki/Insulin_(medication))
 29. https://en.wikipedia.org/wiki/Flavr_Savr
 30. <http://calag.ucanr.edu/Archive/?article=ca.v054n04p6>
 31. <https://www.npr.org/sections/health-shots/2018/11/26/670752865/chinese-scientist-says-hes-first-to-genetically-edit-babies>
 32. <http://www.crisprtx.com>
 33. <https://en.wikipedia.org/wiki/Gene>
 34. <https://ghr.nlm.nih.gov/primer/basics/chromosome>

edubirdie.com