

Genetic Engineering



What is the difference between the mice in these two groups?



What is genetic engineering?

Genetic engineering is the **direct modification of an organism's genome**, which is the list of specific traits (genes) stored in the DNA.

Changing the genome enables engineers to give desirable **properties** to different organisms.

Organisms created by genetic engineering are called **genetically modified organisms (GMOs)**.



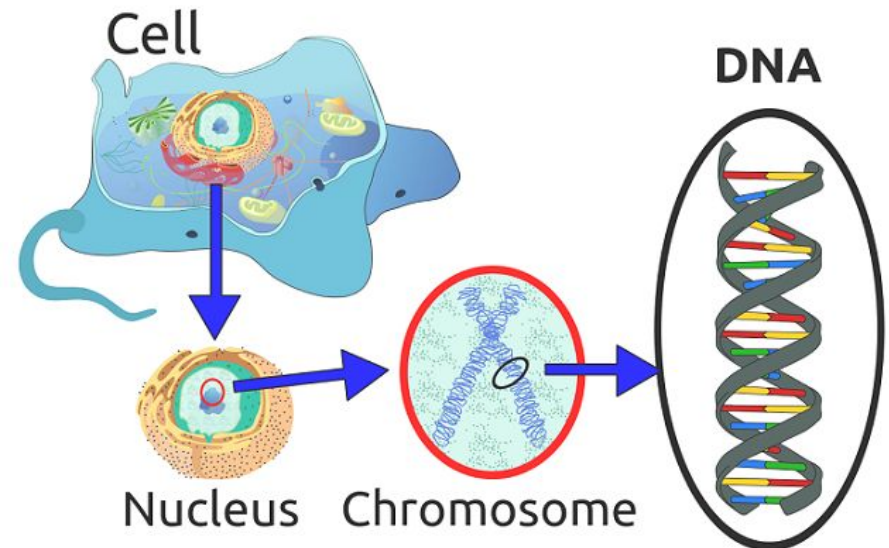
History of GMO Development

- 1973:** created first genetically modified bacteria
- 1974:** created GM mice
- 1982:** first commercial development of GMOs (insulin-producing bacteria)
- 1994:** began to sell genetically modified food
- 2003:** began to sell GMOs as pets (Glofish)
- 2010:** 29 countries had planted commercialized biotech crops
- 2015:** The first genetically modified animal to be approved for food use was AquAdvantage salmon in 2015.



What is the GMO process?

- All genetic changes **affect the protein synthesis** of the organism.
- By changing which proteins are produced, genetic engineers can **affect the overall traits of the organism**.
- Genetic modification can be completed by a number of different methods:
 - Inserting **new genetic material** randomly or in targeted locations
 - Direct **replacement of genes (recombination)**
 - **Removal** of genes
 - **Mutation** of existing genes

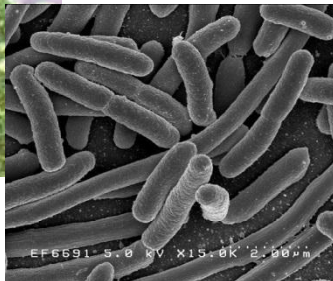
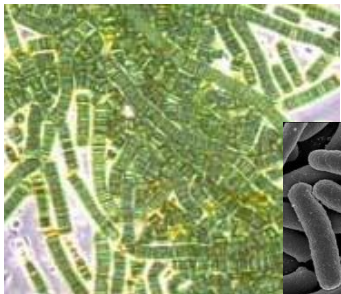


GMO Bacteria

Bacteria are the most common GMOs because their simple structure permits easy **manipulation** of their DNA.

One of the most interesting uses for genetically modified bacteria is the **production of hydrocarbons (plastics and fuels)** usually only found in fossil fuels.

- **Cyanobacteria** have been modified to produce plastic (polyethylene) and fuel (butanol) as byproducts of photosynthesis
- **E. Coli** bacteria have been modified to produce diesel fuel
- <https://www.youtube.com/watch?v=O1Xd3X6XqFY>



Engineering Plants

How might genetic engineering modify plants to solve everyday problems?

(Consider world hunger, weather problems, insecticide pollution...)



Genetically Modified Crops

GMO crop production in Canada (2015):

- 60% of soybeans
- 95% of canola
- 80% of grain corn
- 100% of sugar beets



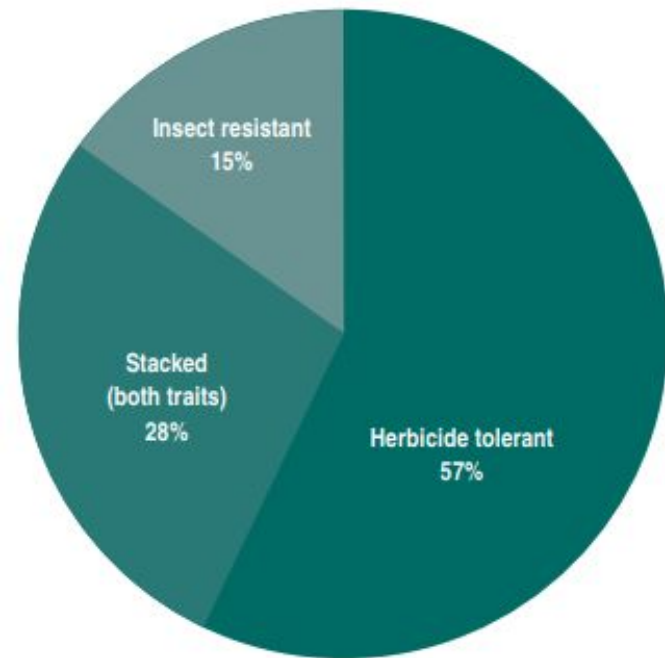
Example:

- One common modified crop is Bt-corn.
- A gene from the *Bt* bacteria is added so the corn produces a protein that is poisonous to certain insects but not humans.

Genetically Modified Crops

- Almost 100% of GM crops grown in Canada and the world are engineered with one, or both, of just two traits. These are **herbicide tolerance and insect resistance.**

FIGURE 2: GM TRAITS AS PERCENT OF TOTAL GM AREA



MAJOR GM TRAITS

Herbicide tolerance

Insect resistance

MINOR GM TRAITS

Virus resistance

Drought tolerance

Reasons to Genetically Modify Crops

- Insect resistant
- Herbicide resistant
- Drought/freeze resistant
- Disease resistant
- Higher yield
- Faster growth
- Improved nutrition
- Longer shelf life



- <https://www.youtube.com/watch?v=aKohkmt6GRI>

Engineering Animals

Could genetic engineering be used to modify any animals to solve problems?



Bioluminescent Animals



What's the use??!!

- **Disease detection** using bioluminescent imaging (BLI) to identify different types of cells
- **Protein** tracking
- **Novelty pets** (Glofish are available now)
- <https://www.youtube.com/watch?v=Qm5Bj5xNefM>



HOW THEY COMPARE



Fast-Growing Salmon

Genes from **two other fish** cause this salmon to continually produce **growth hormones**

Less Smelly Cows

Modifying bacteria responsible for **methane production** in cattle results in **25% less-flatulent cows**



Could Spiderman Be Real?



Web-Producing Goats

Spider genes in goats enable the production of spider silk in goat milk



Task: Are Genetically Modified Foods Safe?

- Foods resulting from genetically modified plants have already been introduced into the food supply in some countries, including Canada, the United States and those in Europe. But not everyone thinks these foods are safe.
- You've been appointed to research and report to a special **Health Canada** board about these foods. Find out all you can and then decided for



Task: Are Genetically Modified Foods Safe?

- You will be split up into a group of three and assigned whether your group is arguing **FOR** or **AGAINST** genetically modified foods.
- You will have only **30 minutes** to do your research before you **present to the class** so use your time wisely.
- Use the questions on the sheet to guide your research.
- As the other groups are presenting, fill in the back of your sheet and categorize the pros and cons of GMO's.

- **Some helpful links:**

<http://www.pbs.org/wgbh/harvest/>

<https://www.healthline.com/health/gmos-pros-and-cons>

<https://www.nationalgeographic.com/people-and-culture/food/the-plate/2016/06/what-would-a-world-without-gmos-look-like-/>

<https://goo.gl/qw1Gmz>

GMO Pros and Cons

Watch: <https://www.youtube.com/watch?v=7TmcXYp8xu4>





Trivia?

GMO
Fact or
Fiction?

Fact or Fiction?

GMOs are created by injecting chemicals into food AFTER it is harvested.

Fiction

GMOs are developed through genetic engineering where scientists identify and insert specific traits into the DNA of the seed before it is ever planted. The plant grows just like conventional (non-GMO) seeds. The transgenic trait is then transferred to other varieties through traditional cross-breeding.

[See "The Life of a Seed-Jake, a GMO Seed"](#)

Fact or Fiction?

After a GMO is developed, it is thoroughly evaluated by the Health Agencies to identify unintended consequences to the environment or to our health if consumed.

Fact

It takes many years for a GMO to be approved first for field testing and second for commercial production.

Fact or Fiction?

GMOs have bombarded the produce section of the grocery store. It is difficult to avoid GMO fruits and vegetables.

Fiction

There are only 10 approved varieties of GMO plants. Of those crops, 5 could be found in the produce section. They are sweet corn, papaya, potatoes, squash, and the Arctic apple. (The arctic apple won't be available on store shelves for a few more years)

Fact or Fiction?

The bulk of GM crops that are harvested in the US are for the use of livestock feed.

Fact

GM field Corn, Alfalfa, Soybeans, and the by-products of sugar beets and cotton harvested in the United States are all used to feed livestock.

Fact or Fiction?

Using GM crop varieties in every country would be beneficial.

Fiction

Many third world countries do not have the technology and resources to utilize the benefits of GM crops. For example, if a farmer in another country does not have access to herbicides, using herbicide tolerant crops would not be beneficial.

Fact or Fiction?

The implementation of GM seeds over the last 20 years has increased the price of food.

Fiction

A study shows that the prices of corn, soybeans and canola would probably be 5-9% higher than if GM technology was not available to farmers.

[The Production and Price Impact of Biotech Crops](#)

Fact or Fiction?

Health studies about the safety of consuming GM crops are less than 20 years old.

Fact

GM crops have only been in production since 1996. While studies have shown they are safe, their scope is limited to the amount of time they have been in production and use.

Fact or Fiction?

GMOs are NOT directly linked to being a cause for cancer.

Fact

GM crop varieties pose no greater risk of increasing the risk of cancer than their conventional counterparts.

[A decade of EU-funded GMO Research](#)

[Compilation of Research on GM Crops](#)

Fact or Fiction?

Studies show that GMOs are linked to an increase in allergies.

Fiction

90% of all allergies are caused by peanuts, tree nuts, milk, eggs, wheat, soy, shellfish, and fish. To date, only soy even has a GM variety. See more explanation:

[Are GMOs causing an increase in allergies?](#)

Fact or Fiction?

GMOs are contributing to the death of butterflies.

Fiction

Butterflies would need to eat the Bt found in GM crops to have it kill them. Butterflies are not pests, and therefore do not feed on the actual plants.

[Dominic Reising, North Carolina State University](#)

Fact or Fiction?

There aren't any known environmental risks to producing and growing GM crops.

Fiction

Potential environmental risks are known, which leads to monitoring and testing before approval of a new GM crop.

Scientists monitor GM crops to watch for unintended consequences that could be seen long term such as herbicide tolerance, biodiversity concerns, and effect on non-target organisms.