TeachEngineering

STEM Curriculum for K-12

Genetic Engineering
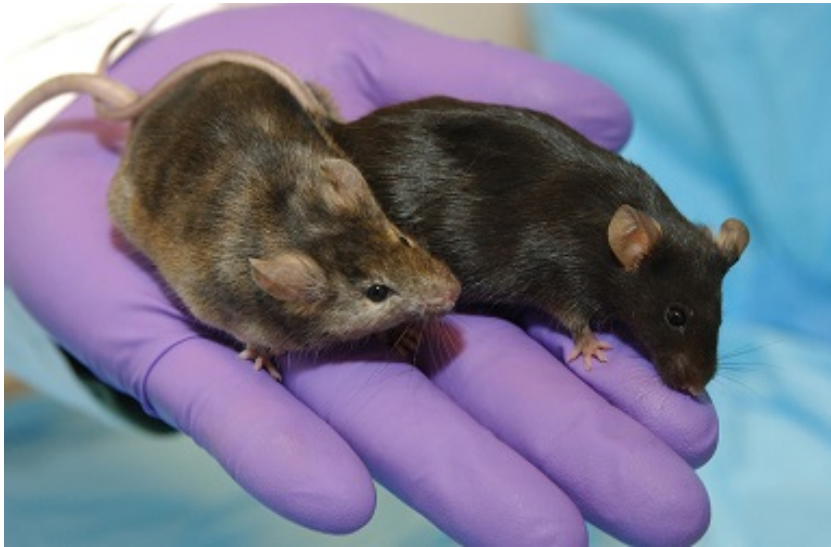
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Genetic Engineering

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)

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**

Cell

Nucleus Chromosome

DNA
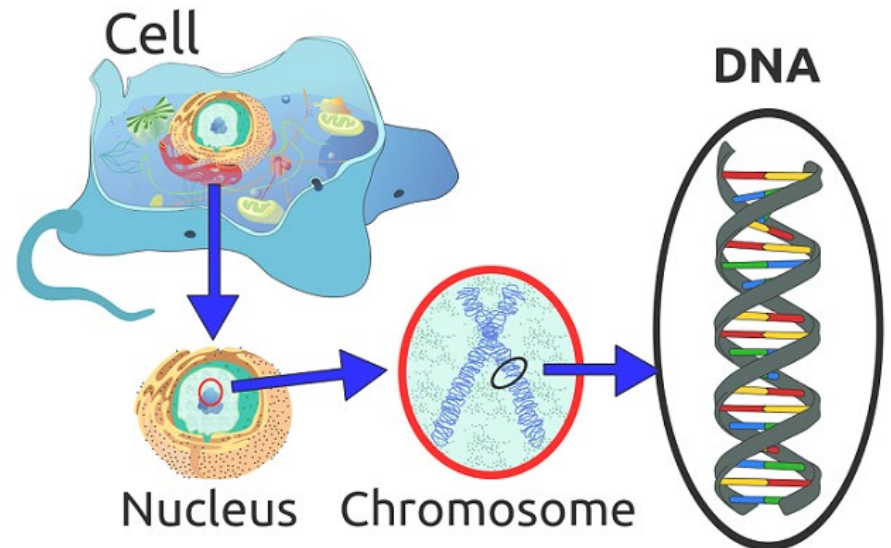
GMO Bacteria

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**
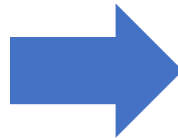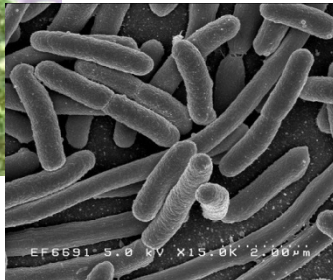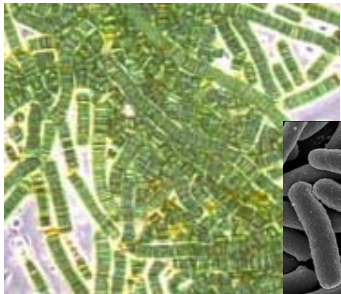
Engineering Plants

How might genetic engineering modify plants to solve everyday problems?

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

Genetically Modified Crops

GMO crop production in the US (2010):

- **93% of soybeans**
- **93% of cotton**
- **86% of corn**
- **95% 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.**

Banana Vaccines
Modified virus injected in sapling tree causes the bananas to contain virus proteins

Venomous Cabbage
Scorpion genes added to the cabbage prevent insects from eating it

Other Reasons to Genetically Modify Crops

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

Engineering Animals

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

Bioluminescent Animals

Uses:

- **Protein tracking**

- **Disease detection using bioluminescent imaging (BLI) to identify different types of cells**

- **Novelty pets (Glofish are available now)**

HOW THEY COMPARE

GM salmon
Length: **24ins**
Weight: **6.6lb**

Farm salmon
Length: **13ins**
Weight: **2.8lb**

*Both fish are 18 months

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

GMO Concerns

What are some concerns regarding genetically modified foods and animals?

- **Risk to human health; unsafe to eat**
- **Harm to the environment and wildlife**
- **Increased pesticide and herbicide use**
- **Farmers' health**
- **Seed and pollen drift**
- **Creation of herbicide-resistant super weeds**
- **What about genetic engineering in humans?**

Nearly 50 countries around the world, including Australia, Japan and all of the countries in the European Union, have enacted significant restrictions or full bans on the production and sale of genetically modified organism food products, and 64 countries now have GMO labeling requirements.