**GENETIC ENGINEERING**

* **Directly** changing the genome to make improved or new organisms.
* Can use molecular **cloning** (clone the desired DNA strand, injecting into the DNA so it replicates)
* Can use gene **targeting** – a specific gene (or set of genes) manipulation – remove the gene; add one, or introducing a **point mutation**.
* **GMO** – genetically modified organism
	+ Originally bacteria in **1973**, mice in 1974
	+ More commonly genetically modified *food.* (in production since 1994)
* Vital in research, agriculture, medicine, industrial biotechnology
* Laundry detergents, medicines like insulin, are now produced using genetic engineering.
* Use **RNA** to make new sequences of DNA by manipulating the **codon** (commonly)
* Not necessarily stem cell and cloning, but genetic engineering techniques can be employed
* In Canada, something is genetically modified if it has a trait that the **original does not**.
* Plants are modified for insect protection, virus protection, enhanced nutrition, edible vaccines, and ability to withstand environmental pressure
* **Selective breeding** has been happening for **thousands of years** – this is a form of genetic manipulation.
* However, the direct manipulation of DNA has only existed since the **1970s**.
* Genetically engineered **insulin** was approved by the FDA in 1982.
* Many protests, legal limitations (**ice-minus in 1987**)
* 2010: scientists create a synthetic genome and insert it into an empty bacterium. The result, Synthia, can **replicate and produce proteins**.
* 2014: Bacterium with a **unique base pairing**, making it the first organism with an expanded genetic alphabet.
* Engineered nucleases can result in a gene knockout (when a gene is made completely inactive)
* 1% of bacteria have the capability to take on **foreign DNA**, but you can trigger this response in other bacteria with **stress** (like heat or electricity). This makes the cell membrane more **susceptible** to extra DNA, and it will integrate into the copied DNA/RNA strands *or* it will be **extrachromosomal** (DNA found outside the nucleus of the cell).
	+ Deadpool is found in reality. WOAH.
* In animals, it is very important that the inserted DNA is in the embryonic cells, so that is spreads. (Embryonic cells act like stem cells.)
	+ First generation will be heterozygous. Must be bred with each other for F2 to be homozygous.
* Mendelian inheritance tactics are used for observation
* **Gene therapy** is genetic engineering in humans.
	+ *Very* controversial.
	+ 2012: first form of gene therapy permitted in the world after being permitted by the European Commission for clinical use, Glybera. Compensates for rare genetic disease, lipoprotein lipase deficiency which can cause severe pancreatitis.
		- LPL gene inserted into organism – free-floating DNA. Followed by immunosuppressive treatment so the immune system does not try and attack it.
	+ **CRISPR** (Clustered regularly interspaced short palindromic repeats) is seen as a major breakthrough in genome editing (with the use of CRISPR Cas9-gRNA)
		- **Naturally occurring** (found in bacteria)
		- Prokaryotic DNA with **repeating base sequences**
		- These repeating base sequences match the DNA of certain viruses – so the organism is keeping a sort of **database** of the viruses, so that when the virus gets to the body a second time, Cas (CRISPR-associated proteins) can slice DNA and obliterate the virus.
			* CRISPR takes certain sections of the virus DNA and turns it to **RNA**, which bonds with the Cas. They then float through the cell, so if they find something that matches the RNA, Cas cuts it in two so it cannot replicate itself.
		- Using this technique, scientists can give Cas9 a **desired sequence** and it’ll go and copy or paste whatever sequence you want in the genome.
			* Cas9 can recognize sequences 20 bases long, so this allows for **precision** when it comes to genes, instead of just cutting whenever it sees the three-letter code it wants everywhere.
		- Still in **early development** but if more testing is permitted, we can definitely witness some incredibly cool advancement in science.
		- This form of precise gene engineering (which is pretty simple, efficient) can completely revolutionize medicine and even ecology as we know it. It’s just an **ethical battleground**.
	+ 2015 – Scientists urge the global community towards a temporary ban on inheritable edited human genomes until laws are put in place
* Organisms can be modified to find out the **effect of certain genes**. There are a variety of techniques for this:
	+ Gene knockout – Insert a non-functional version of gene. Embryonic stem cells take the altered gene, and replace the original, functional copy. The stem cells are put into a blastocyst, and then in a surrogate mother.
	+ Opposite of the gene knockout – increase the function of a gene, by inserting another copy or making the proteins produce more frequently. Used to determine if a gene is necessary for a certain function in the organism.
	+ Tracking – inserting a dye into the copy of the gene to juxtapose the studied one. However, this can mess up results.
* Genetic engineering has also been used to make purple carnations, blue roses, BioArt (art using fluorescently dyed proteins), and for-sale glowing fish (“GloFish”).
* GM techniques and GM organisms are under **intellectual property law**, which means you can **patent** it if you discover it. This is controversial as, if genetic engineering is claimed to be used for medicine or for the benefit of the general public, does it really need to be patented?

<https://en.wikipedia.org/wiki/Genetic_engineering>

<http://gizmodo.com/everything-you-need-to-know-about-crispr-the-new-tool-1702114381>

<http://futurism.com/mutant-mice-how-crispr-can-put-genetically-modified-organisms-within-everyones-reach/>

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