Lesson 12: Tuesday, April 8, 2020. Biology MHS

AIM: HOW do scientists cut genes out of one organism and insert them into another? Have we done anything else interesting with our knowledge of genetics? Are there any problems with all this biotechnology stuff?

Recall that **genetic engineering** is a modern technique used by scientists to *insert genes* into an organism. By inserting a gene, the GMO can *produce a new protein* resulting in a *new trait*. Humans have greatly benefitted from this technique in the fields of **agriculture** and **medicine**. We have *inserted genes* into crops to make them drought, disease, and insect *resistant*. We have *inserted genes* to add vitamins and increase growth rate. Genetically modified food has greatly increased our world food supply and has made it more stable. We no longer have to fear about an insect invasion destroying our nation's food supply. Bacteria modified with human genes are used to produce human hormones and enzymes, which have been used to provide medications like insulin for patients who need it. Did you know that before we genetically engineered bacteria to produce human insulin, we used to extract insulin from the pancreas of pigs and cows from meat farms?! Not only was this insulin *extremely expensive*, but because it was not human, it sometimes resulted in side effects and *allergic reactions*. Today, insulin is available, safe, and **affordable** thanks to genetic engineering.

So, HOW do we *cut* and *paste* genes?! The process of genetic engineering requires **specific enzymes**. Enzymes are used to digest and **cut** the desired gene out of one cell, and enzymes are used to **paste** this gene into the genetic code of the next organism. Sometimes, enzymes are described as *"molecular scissors."* One challenge of genetic engineering is finding the right enzyme! This can be tricky, because enzymes are very specific.





This bacterial cell can now be used to produce:

(1) the bacterial gene for insulin that can be inserted into humans

- (2) human genes for enzymes that can be inserted into humans
- (3) insulin that can be used by humans
- (4) enzymes necessary to treat human diseases



Cloning:

With our knowledge of DNA and genetics, we have cloned organisms! The first organism that we cloned was a sheep named Dolly in 1996. The technique for cloning a multicellular organism is shown to the left. You do not need to memorize this technique, but you do need to know that the resulting organism is **genetically identical** to the DNA (body cell) donor.

• Some people were **not pleased** that we cloned an organism. Some people are not happy with genetic engineering in general. What happens if engineered genes mix with wild populations? What happens if the inserted genes affect the health of the organism? If we can clone sheep, can't we clone humans? If we insert genes into organisms to change their traits, then can we insert genes into humans and change their traits too? If we introduce genes to organisms, we can't really "un-do" this. Genes can be passed on through reproduction.

• Genetic engineering to some people is considered **unethical**- they don't think that it is **morally** right. Some people are scared that genetic engineering *could go too far*, and that humans have no right to manipulate the genes of organisms that have evolved naturally over millions of years.

Biotechnology and bioethics questions:

1. Compare and contrast selective breeding and genetic engineering. Both are used for similar reasons, but the techniques are *very* different.

Selective Breeding	BOTH	Genetic Engineering

- 2. What "tool" is used by scientists to cut and paste DNA?
- 3. Explain how humans have benefitted from genetic engineering. Give one specific example from the field of agriculture, and one specific example from the field of medicine.
- 4. A farmer has a breed of yellow tomatoes. However, the farmer thinks that they would sell better if they were bright red.
 - a. Explain how the farmer could use *selective breeding* to produce the desired tomatoes.
 - b. Explain how the farm could use *genetic engineering* to produce the desired tomatoes

- 5. With our knowledge of genetics, human *could* do A LOT. But, there are a lot of restrictions and regulations in the field of biotechnology. Why? How do some people feel about genetic engineering?
- 6. Identify one specific concern related to genetic engineering.
- 7. Briefly describe the result of cloning.