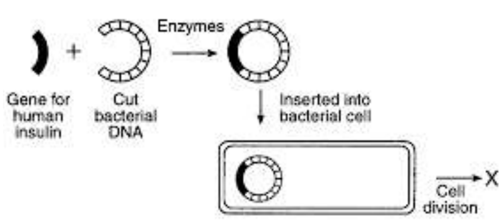
Lesson 11: Monday, April 7, 2020. Biology MHS
AIM: ***How has our understanding of genetics and DNA led to advancements in the fields of agriculture and medicine?***

Did you know that DNA wasn't even discovered until the 1950s!? Since then, our knowledge of DNA, genes, and inheritance has increased tremendously. Did you know that in 2003, the *Human Genome Project* was completed? Scientists identified *every single human gene*, *which chromosome every gene was located, AND the base sequence of every gene??* That's cray.

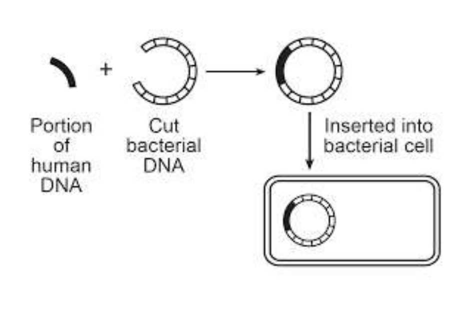
Our knowledge of genetics has led to new technology and advancements in the field of **agriculture** and **medicine**. One technique you need to know about is genetic engineering. **Genetic engineering** is a technique in which scientists **transfer genes** from *one organism* to *another*. By giving an organism a *new gene*, the organism is able to make a *new protein*, which will give the organism a *new trait*. Because DNA is a **universal genetic code**, we can transfer genes between *different species*. Scientists have transferred genes from bacteria to corn plants, from fish to tomatoes, from salmon to salmon, and from humans to bacteria! The organism that *receives* the gene is called a "**genetically modified organism**," or a **GMO**. How do we benefit from GMOs??

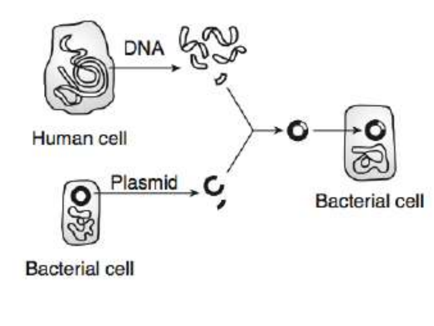
- Scientists have taken a **gene** from a soil bacteria and ***inserted*** it into corn. This gene allows the corn to *produce a protein* that helps to *repel harmful insects.* The protein is safe for humans and for the corn, and allows the corn to be **insect resistant.** This means that farmers have to use *less* pesticides (chemical sprays) and that *more corn* survives. This means more corn for us to eat and cheaper prices!
- Scientist have taken a **gene** from an Artic flounder (fish) and ***inserted*** it into tomatoes! This gene codes for an "antifreeze" *protein* that allows the fish to survive in frigid waters. The gene also gives the tomato the ability to survive freezing temperatures. This means that the tomato could be grown year-round in cold climates. Will this make the tomato taste like fish? **NO**- we have transferred *one gene* for *one protein* that has nothing to do with flavor.
- Humans have **transferred a gene** from one species of salmon (that we don't like to eat) to another species of salmon (that we do farm for consumption). This gene *controls growth*. The GMO salmon grow twice as fast and twice as large compared to non-GMO salmon. This means more food for humans.
- Scientists have **transferred the human gene** for **insulin** into *bacteria*. Bacteria are asexual, so all it takes is one genetically engineered bacteria to produce many GMO bacteria. Each time a bacterium divides, *it will pass on the* ***inserted gene*** *as well*. The genetically engineered bacteria will *express* the human gene for insulin, and *will produce human insulin*! Scientists can *extract* and *purify* the insulin and give it to patients with **diabetes** who cannot produce sufficient insulin on their own! This is one of the most important applications of genetic engineering**.** Since enzymes and most hormones are *proteins* that are *coded for by genes*, we have genetically engineered bacteria to produce the human hormones and enzymes. We give these hormones and enzymes to people with disorders who cannot produce the chemicals on their own.

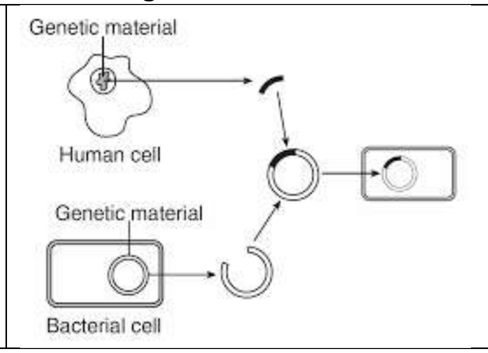


This diagram shows genetic engineering. FIRST, the human gene was isolated and cut out of a human cell. THEN, the bacteria of a DNA was "opened." Then, ***the human gene was inserted into the bacterial DNA***. The bacteria, through cell division, will pass on this gene to all bacteria that it created by asexual reproduction. NOTE: bacteria have a "ring of circular DNA" called a **plasmid**. Even though it doesn't look like our DNA, it still represents the bacteria's genetic code. By inserting the human gene into this "ring," we have genetically engineering the bacteria.

Look at these 3 diagrams of genetic engineering that are commonly used on the Regents exam.







Here are three Regents diagrams of genetic engineering in bacteria. In each picture, we see that a **GENE** (a portion of DNA) was *removed* from humans. We see that the gene was **INSERTED** into the bacteria's DNA. We know that the bacteria can pass on this gene through *asexual* reproduction, and that we can use bacteria to produce human hormones and enzymes that can be used for **medications**.

Regents Practice Questions:

Barley Gene Lowers Emissions from Rice

Over half the people on the planet eat rice as a staple food. Growing rice emits methane, a potent greenhouse gas—to the tune of 25 million to 100 million tons of methane every year, a notable contribution to human-caused greenhouse gas emissions…

…When rice paddies are flooded, methane-producing bacteria thrive on the carbohydrates secreted by rice roots in the oxygen-free soils. The rice plant itself acts as a conduit [pathway], transmitting methane from the soil into the atmosphere… Source: Times Tribune

Scientists have incorporated a barley gene into a type of rice and produced rice plants that have much lower methane emissions. It is most likely that the scientists incorporated the barley gene into the rice, producing a new variety, using the process of

(1) selective breeding
(2) meiosis, followed by recombination
(3) genetic engineering
(4) sexual reproduction, followed by mitosis

As a way to reduce the number of cases of malaria, a human tropical disease, a specific DNA sequence is inserted into the reproductive cells of Anopheles mosquitoes. Which process was most likely used to alter these mosquitoes?

(1) cloning studies
(2) genetic engineering
(3) natural selection
(4) random mutations

One likely reason bacteria would be grown in laboratory cultures would be to

(1) increase the number of antibiotics produced by human cells
(2) eliminate the cloning of cells that can fight disease
(3) increase the production of specialized proteins by using genetic engineering
(4) decrease the amount of bacteria naturally present in organisms