INTRODUCTION TO DNA

HISTORY OF DNA

Discovery of DNA

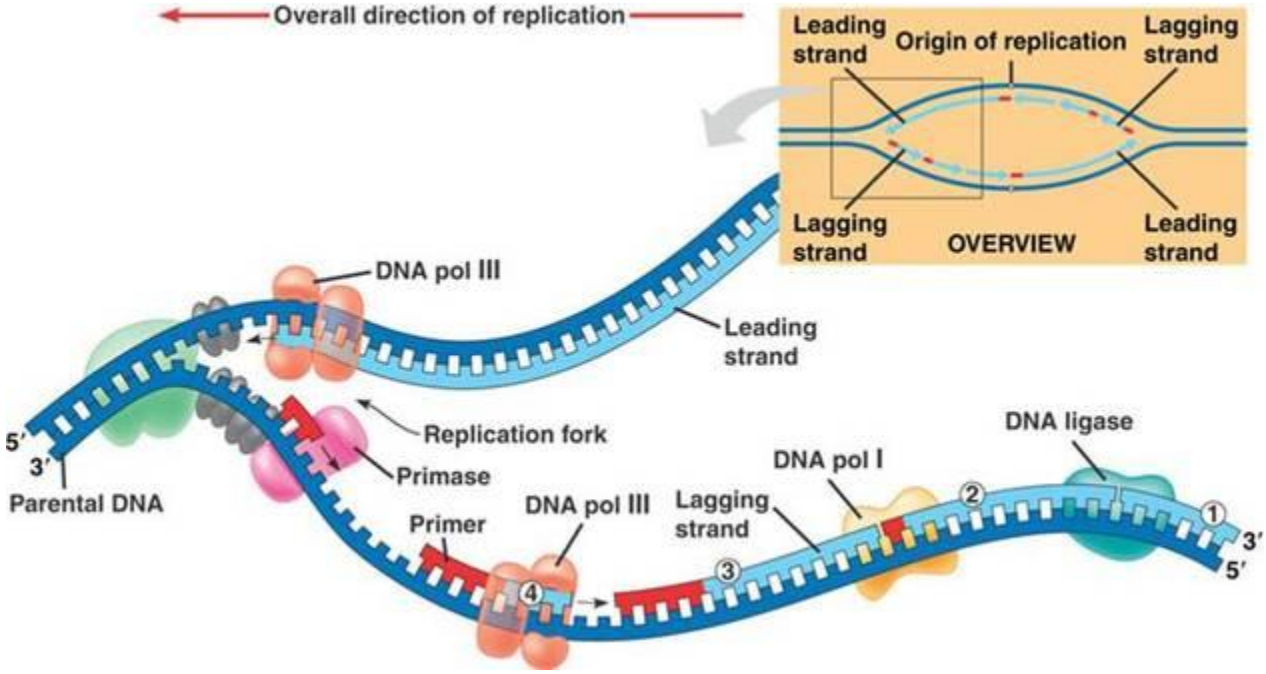
In 1869, proteins were believed to be the hereditary material because there was an abundance of them and they had several different types. Friedrich Miescher investigated the chemical composition of DNA using pus cells. He used pus because he could easily obtain it by collecting used bandages from nearby clinics. Through his experiments, he found and isolated a new molecule. It was found inside the nucleus, so Miescher named it nuclein.

Later in the 1930s, Joachim Hammerling experimented with *Acetabularia*, a unicellular green alga. This alga is five cms long and has three parts to it, a stalk, cap region and the food which contains the nucleus. In these experiments, Hammerling removed the caps from some and the foot from others. He noticed that the alga without the caps would regrow their caps, but those without feet could not regenerate anything. The theory that Hammerling came up with was that the hereditary information was located in the foot of the alga, possible in the nucleus. He conducted more experiments with different plants and concluded that the hereditary information was in the nucleus.

Then in the 1920s, scientists found that DNA had three main components; a deoxyribose sugar, a phosphate group that is negatively charged and a nitrogenous base. Rosalind Franklin and Maurice Wilkins were each using X-ray diffraction analysis of DNA to determine its structure. James Watson and Francis Crick were also looking for the structure of DNA. Wilkins showed Watson and Crick the data that Franklin had found during her diffraction experiments. Watson and Crick now had the last piece of information they needed and discovered that the structure was a double helix. Then in 1952 it was accepted that DNA is the source of the hereditary information and not protein.

In DNA, there are four nitrogenous bases found in DNA. Adenine and guanine are two double-ringed structures called purines. Thymine and cytosine are single-ringed structures called pyrimidines. These nucleotides are on two anti-parallel strands.

Adenine always pairs with thymine and guanine always pairs with cytosine. The sugar and phosphate act as the backbone on the DNA.



DNA Replication

DNA is made through a replication process. This replication process is called semi-conservative replication, the DNA splits into two strands, called RNA, and rebuilds the missing half on each strand. These nucleotides are paired in groups of three, and these groups are called codons. When RNA goes through protein synthesis, the codons code for a specific protein to add to a polypeptide chain.

During the replication process, mistakes can happen if the wrong nucleotide is read and coded for, this causes mutations. There are three types of mistakes that can happen, which causes three types of mutations.

Substitution - is when one base in a DNA sequence is replaced by another base.
Deletion - is when a single, pair or group of bases is eliminated from the sequence
Insertion - is when a new nucleotide is added to the sequence

Silent mutations - are when a single nucleotide is changed but the new codon still codes for the same amino acid
Missense mutations - are when one of the nucleotides is changed and the new codon codes for a new amino acid
Nonsense mutations - are when one nucleotide is changed and the new codon is a STOP codon

What is Genetic Engineering?

Genetic engineering is altering the sequence of DNA molecules. It uses a set of technology that can change the genetic makeup of cells, as well as moving these genes across species boundaries to produce novel organisms. These genes determine a specific trait an

organism will have, so by moving these genes from one organism to another, the traits are transferred. Genetic engineering gives the opportunity for new combinations of gene, giving new combinations of traits that do not happen normally in nature. This type of artificial breeding is extremely different from traditional plant and animal breeding, which can use theories of natural selection to get better offspring. When these organisms are changed through genetic engineering they are called genetically modified organisms (GMOs).

People use genetic engineering to for several reasons. A common reason is to create stronger and better organisms, for example they would create a potato that is resistant to phytophthora infestans, which is a potato disease that was the cause of the Irish potato famine in the 1840s. This would make the potato plant more reliable and drastically reduce the chance of another famine to happen. Potatoes naturally do not have a resistance to this disease making it impossible for this immunity to happen in nature. But scientists can take find any plant that has this resistance and take the genes for that specific resistance and mix it with the genes of potatoes to create a potato plant that is immunity to this disease. Genetic engineering has almost no limits, because there is only one language of life, DNA. And because of that there isn't any species that they cannot combine the genes from. They have been able to create things as crazy as a chicken with four legs and no wings. There are very few limitations to what genetic engineering can do; our imagination, and our moral or ethics code. Without putting limits in place, than that lets scientists change the very basis of life, permanently. A mistake could occur making something that could be very dangerous, and if we don't monitor what scientists are doing than these things could happen.

METHODS OF GENETIC ENGINEERING

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Genetic engineering is the technique of biotechnology which helps in preparing recombinant DNA. Recominat DNA (rDNA) is a form of artificial DNA that is created by combining two or more sequences that would not normally occur in nature. There are three main methods of genetic engineering which are the plasmid method, the vector method, and the biolistic method.

The Plasmid Method -

This method is the most commonly used method in genetic engineering. This method uses small circular pieces of a DNA molecule called plasmids. This method is mainly used for altering microorganisms such as bacteria.

1) The plasmid is inserted into a container containing restriction enzymes. Restriction enzymes cut up the plasmids into small pieces.

2) Using the restriction enzymes, these cut pieces of plasmids are inserted into the bacteria and due to which sticky ends are produced. A sticky end refers to how the restriction enzyme cut the DNA. If the cut was straight then it is a blunt end, but if it is a

staircase than its sticky.
3) The sticky ends on the DNA from the plasmids combine with the sticky ends on the DNA inside the bacteria to form a ring of DNA. Other enzymes are added to make those ringed DNA molecules more stable. After they stabilize, they are put in safety to use for further processes.
4) A culture of live bacteria is then prepared with the newly formed plasmids and are placed together. These plasmids will then enter into the bacterial cell and start expresses itself. During the expression, the plasmid will synthesize new proteins or antibiotic resistance genes. These new genes will help distinguish the plasmid bacteria from the non plasmid bacteria.

The Vector Method -

The vector method uses techniques similar to the plasmid method. This method uses vectors, which are small carrier molecules, which are normally viruses. Viruses are made of a protein capsule and have their DNA inside, they attach onto a cell then inserts its DNA or RNA into the host cell, then it detaches itself. The DNA, now inside the host cell, will start replicating itself by using the genetic information of the host cell, which means the gene that was inserted will now be part of the host cell. The vector method is better than the plasmid method because the plasmid method offers genetic variation because the newly formed plasmids are made with random pieces of DNA, while the vector method uses a specific gene to get a specific result. This will make the host give the desired features.
1) The strand of DNA is put into a container with specific restriction enzymes to separate a specific gene. Once the restriction enzyme cuts the gene of interest, that gene is then isolated from the rest and is ready to be inserted into a vector.
2) This gene is now inserted into a vector, in this case its a virus, and once the virus has accepted the gene of interest, it becomes a recombinant molecule. A recombinant molecule is just a vector with recombinant DNA attached.
3) The vector is now placed with the host cell, where it transfer the DNA to the cell. Once inside the cell the DNA starts to replicate, scientist then stop the vectors own DNA from replicating and only allowing the gene of interest to replicate.
4) The gene is now inside the host cells DNA and now the cell will have this gene.

The Biolistic Method -

The biolistic method is also called the gene gun method, and like its nickname this method uses a gun. This method is mainly used for the engineering of the plants,

although the science is evolving to do animals as well.
1) DNA can become "sticky" under certain conditions allowing it to adhere to abiotic particles such as metals. They normally use tungsten, gold or silver. These metals are extremely small particles, which are now coated with DNA.
2) The particles are placed inside the gene gun and a partial vacuum is created between the target tissue and the gun.
3) The particles are then fired at the target and the DNA is effectively introduced to the cells.

GENETIC ENGINEERING IN PLANTS

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The Grapple

Genetic engineering in plants is much easier than in animals. because plants are easy to manipulate, they grow quickly and they there already is a bacteria (*Agrobacterium tumefaciens)* that can naturally genetically engineer plants. This means there are many more strides in genetically engineered plants for example, several crops that we eat are already genetically modified organisms (GMO). Even though genetically engineering plants is easier than animals, it is still quite difficult, so why do we do it? I believe we do it for two reasons, first to create stronger plants that resistance to diseases, bugs and drought. The second reason is because scientist are bored, and/or they are just curious to see what happens if they mix an apple and grape, hence the creation of the grapple (Image to the left).

Over 400 million arces of farmland worldwide are being used to grow genetically engineered (GE) crops. In America, GE soybeans, corn and cotton make up 93%, 88% and 94% of the total amount of those crops grow, that means a very little percentage was truly not genetically altered. Most of the GE crops grown are engineered to be

resistant to pesticides and/or herbicides. They do this so that the crop fields can be sprayed with weed killer, and every plant will die other than the crops. Other benefits that GE crops can have are they are more nutritious for example, rice is a staple food for many countries but rice lacks vitamin A. In third world countries that normally only eat rice and cannot afford to get vitamin A rich foods suffer the affects of a lack of vitamin A. Some examples are people can get a condition that causes blindness, become more susceptible to diarrhea, respiratory infections and childhood diseases. So through genetic engineering, scientist found a way to introduce a rice produce with vitamin A. Some other things that GE crops can be engineered to do is, to be less susceptible to diseases, have the crops grow faster, extend the shelf life of crops, and make crops able to grow in unfavorable conditions.


Genetically Altered Soybeans

Some of the crops that are genetically engineered foods that have been approved for commercial use are: alfalfa, corn, cotton, papayas, canola, rice, soybeans, squash and sugar beet. There are many more GE crops that are being approved and have been approved but are not on the market.
