GENETIC ENGINEERING

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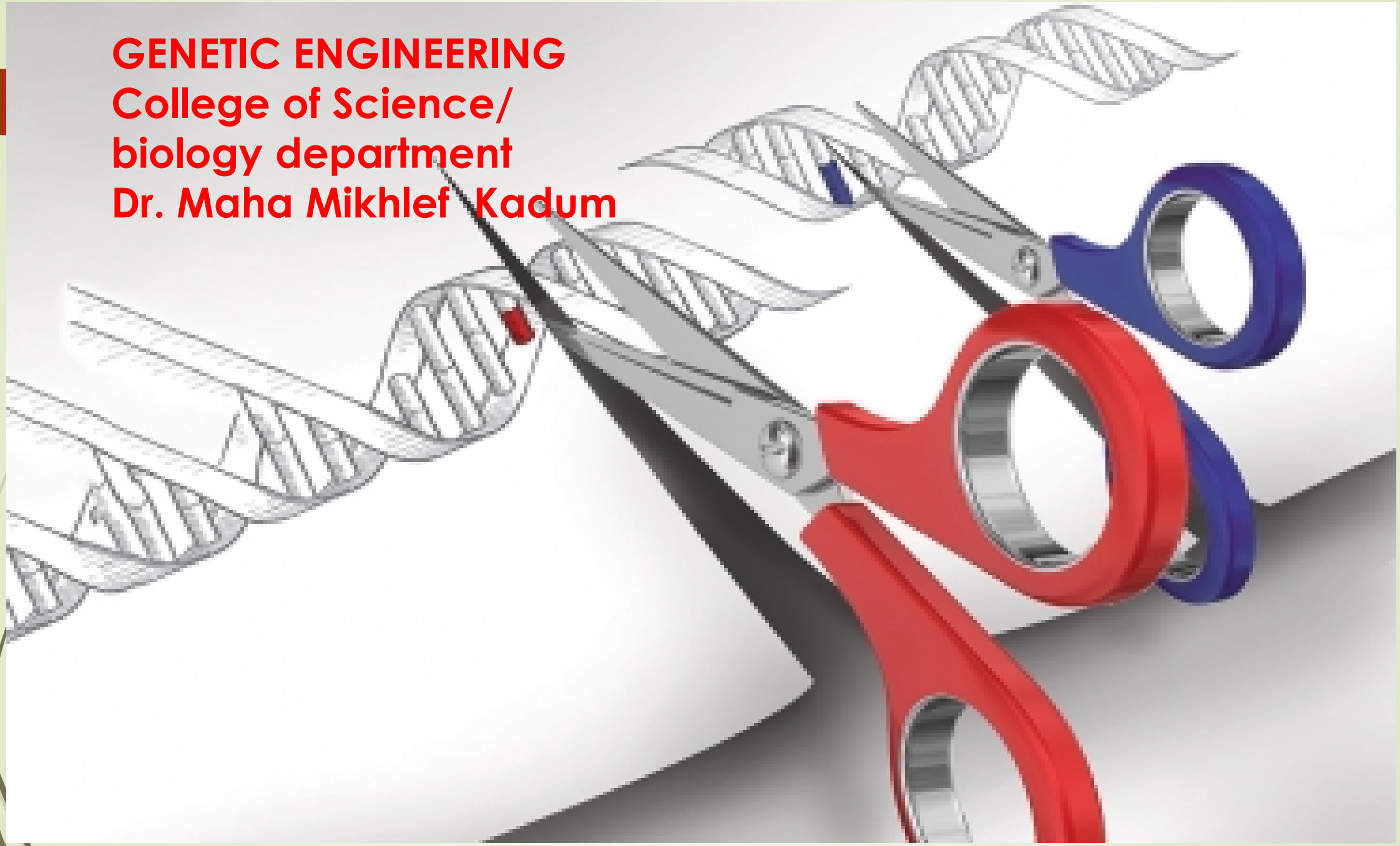


Genetic Engineering

The term genetic engineering is probably the label that most people would Several terms may be used to describe the technologies involved in manipulating genes. However, there are several other terms that can be used to describe the technology, including gene manipulation, gene cloning, recombinant DNA technology, genetic modification, and the new genetics. There are also legal definitions used in administering regulatory mechanisms in countries where genetic engineering is practiced.

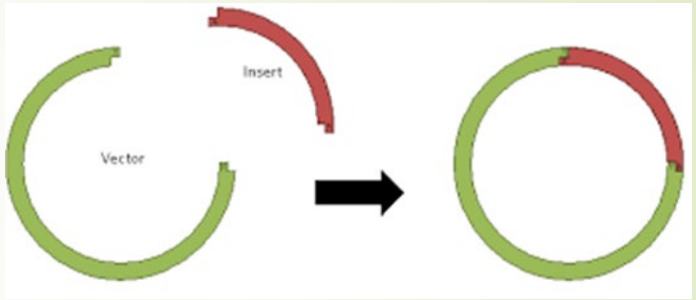
- **Genetic engineering** is the direct manipulation of an organism's genome using biotechnology. It is a set of technologies used to change the genetic makeup of cells, including the transfer of genes within and across species boundaries to produce improved or novel organisms. New DNA may be inserted in the host genome by first isolating and copying the genetic material of interest using molecular cloning methods to generate a DNA sequence, or by synthesizing the DNA, and then inserting this construct into the host organism.

- The science of genetic engineering originated in the late 1960s, the enzyme DNA ligase was isolated. This enzyme can join two strands of DNA together, a prerequisite for the construction of recombinant molecules, and can be regarded as a sort of molecular glue. and early 1970s with the discovery of restriction enzymes . The 1978 Nobel Prize for physiology went to the discoverer of restriction enzymes, Hamilton O. Smith, and the first people to use these tools to analyze the genetics of a virus, Daniel Nathans and Werner Arber.
- Restriction enzymes make it possible to remove a bit of DNA from one organism's chromosome and to insert it into another organism's chromosome . This allows for the production of new combinations of genes that may not exist in nature.

- The first recombinant DNA molecules were generated at Stanford University in 1972, utilizing the cleavage properties of restriction enzymes (scissors) and the ability of DNA ligase to join DNA strands together (glue).
- The importance of these first tentative experiments cannot be overestimated. Scientists could now join different DNA molecules together and could link the DNA of one organism to that of a completely different organism. The methodology was tended in 1973 by joining DNA fragments to the plasmid pSC101, ensure that the target sequence is replicated in a suitable host cell. which is an extrachromosomal element isolated from the bacterium *Escherichia coli.*
- These recombinant molecules behaved as replicons; that is, they could replicate when introduced into *E. coli* cells. Thus, by creating recombinant molecules *in vitro*, and placing the construct in a bacterial cell where it could replicate *in vivo*, specific fragments of DNA could be isolated from bacterial colonies that formed clones (colonies formed from a single cell, in which all cells are identical) when grown on agar plates. This development marked the emergence of the technology that became known as gene cloning

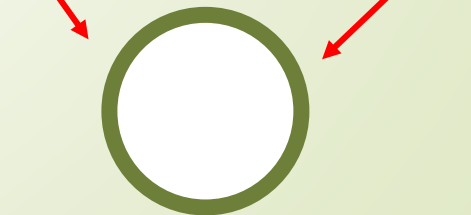
DNA Strand cleavage by restriction enzyme

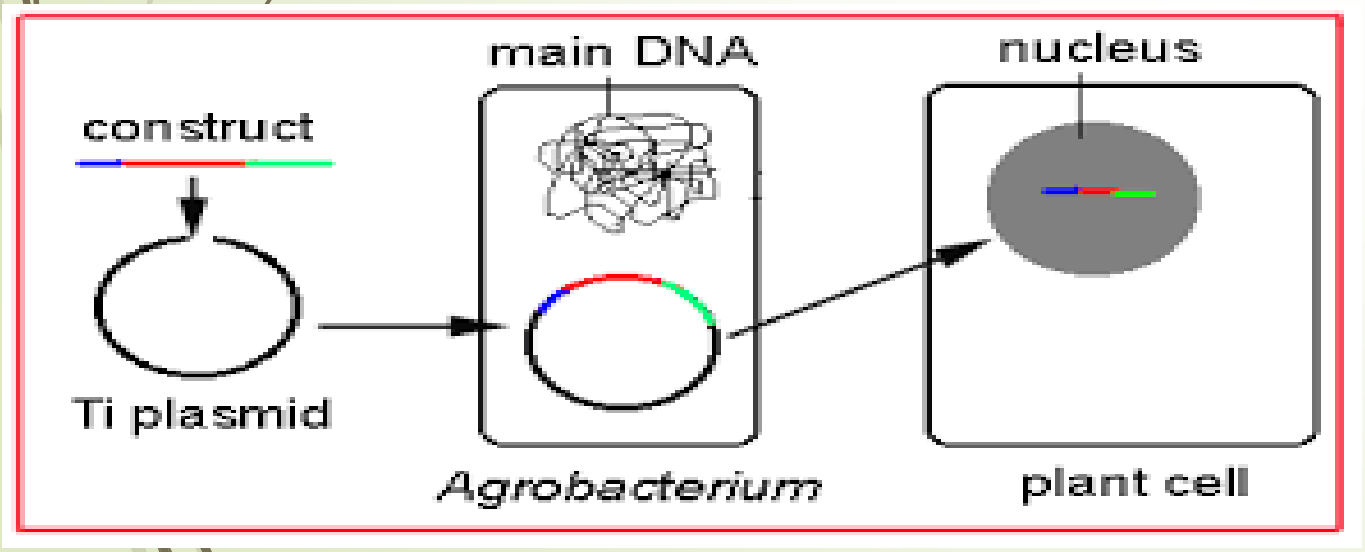
DNA fragment



Ligation the fragment with plasmid

Cleavage the plasmid with RE





GMOs?

- is any organism whose genetic material has been altered using genetic engineering techniques (i.e. genetically *engineered* organism). GMOs are the source of medicines and genetically modified foods and are also widely used in scientific research and to produce other goods. The term more specifically defined type of GMO is a "Transgenic Organism".
- The first GMOs were bacteria generated in 1973 and GM mice in 1974. Insulin-producing bacteria were commercialized and the first diabetic patient in the world was injected with human insulin made in bacteria in December 1980, making this the first genetically engineered product to enter medical practice , and genetically modified food has been sold since 1994. GoldFish, the first GMO designed as a pet, was first sold in the United States in December 2003.

A **genetically modified organism** (**GMO**) This is an organism whose genetic makeup has been altered by the addition of genetic material from another, unrelated organism. This should not be confused with the more general way in which "GMO" is used to classify genetically altered organisms, as typically GMOs are organisms whose genetic makeup has been altered without the addition of genetic material from an unrelated organism.

- if genetic material from another species is added to the host, the resulting organism is called transgenic. If genetic material from the same species or a species that can naturally breed with the host is used the resulting organism is called cisgenic. Genetic engineering can also be used to remove genetic material from the target organism, creating a gene knockout organism

Genetic Engineering Applications

Agriculture

:Crop plants have been and continue to be the focus of biotechnology as efforts are made to improve yield and profitability by improving **crop resistance to insects** and **certain herbicides** and **delaying ripening** (for **better transport and spoilage resistance**). The creation of a **transgenic plant**, one that has received genes from another organism, proved more difficult than animals. Unlike animals, finding a vector for plants proved to be difficult until the isolation of the ***Ti plasmid***, harvested from a **tumor-inducing (Ti) bacteria** found in the soil. The plasmid is "**shot**" into a cell, where the plasmid readily attaches to the plant's DNA. Although successful in fruits and vegetables, the **Ti plasmid** has generated **limited success** in **grain crops**.

Creating a crop that is resistant to a specific herbicide proved to be a success because the herbicide eliminated weed competition from the crop plant. Researchers discovered herbicide-resistant bacteria, isolated the genes responsible for the condition, and "shot" them into a crop plant, which then proved to be resistant to that herbicide. Similarly, insect-resistant plants are becoming available as researchers discover bacterial enzymes that destroy or immobilize unwanted herbivores, and others that increase nitrogen fixation in the soil for use by plants.

How corn is genetically modified

Genes that introduce a new function are spliced into the plant's DNA

GMO = Genetically modified organism
DNA = Deoxyribonuceic acid

1 A gene with the required characteristic is extracted from bacteria

2 The gene is integrated in a fragment of DNA from another bacterium

3 The gene is multiplied in a bacterial culture

4 Copies of the gene are fixed onto tungsten microparticles

5 The microparticles are blasted into vegetable cells under gas pressure. The gene is integrated into cell chromosomes

6 Result: The plant posseses the desired traits, such as resistance to insects or herbicides

Corn borer caterpillar

Gene

Bacterium

Bacterium

Gene

DNA fragment

micro particles

Vegetable tissue

Gas

Monsanto MON 810 contains a gene obtained from Bacillsthuringiensis (a soil bacterium), which produces a protein protecting against the corn borer

Source : INRA

AFP

- **Geneticists are on the threshold of a major agricultural break through. All plants need nitrogen to grow. In fact, nitrogen is one of the three most important nutrients which plant requires.**
- **Although the atmosphere is approximately 78 percent nitrogen, it is in a form that is unusable to plants. However, a naturally occurring *Rhizobium* bacteria is found in the soil and converts atmospheric nitrogen into a form usable by plants. These nitrogen-fixing bacteria are also found naturally occurring in the legumes of certain plants such as soybeans and peanuts. Because they contain these unusual bacteria, they can grow in nitrogen-deficient soil that prohibits the growth of other crop plants. Researchers hope that by isolating these bacteria, they can identify the DNA segment that codes for nitrogen fixation, remove the segment, and insert it into the DNA of a profitable cash crop! In so doing, the new transgenic crop plants could live in new fringe territories, which are areas normally not suitable for their growth, and grow in current locations without the addition of costly fertilizers!**

Projects with genetically modified products

DHA canola: We have developed canola plants which produce high quality oils rich in omega-3 DHA (docosahexaenoic acid). This nutrient is currently only found in beneficial quantities in ocean-based algae, and the fish that eat it. This product could break the world's reliance on fish stocks while meeting the increasing demand for these healthy long-chain omega-3 oils.

- **Leaf oil: We have engineered tobacco plants to have oil seed-like leves of oil in their leaves (around 35 per cent). This product could provide an economically competitive renewable alternative to petroleum diesel.**

- **BT cowpeas: We are part of a global project to improve cowpea production in Africa and are making progress towards incorporating 'built-in' insect pest protection that could help reduce food shortages in some African regions.**