Definitions:

DNA: Acronym for deoxyribonucleic acid, which is a molecule that contains an organism's complete genetic information.

nucleotide: The building block of DNA.

gene: The molecular unit of an organism that contains information for a specific trait (specific DNA sequence).

genome: An entire set of genes for an organism.

plasmid: The circular DNA structure used by bacteria.

protein: Large biomolecules used by an organism for a number of purposes; in this context, to express a desired trait.

trait: A distinguishing characteristic.

recombinant DNA: DNA to which a section has been removed and replaced (recombined) with a new sequence.

Restriction enzyme: An enzyme that "cuts" DNA when specific base pair sequences are present.

GMO: Acronym for genetically modified organism.

Intrduction:

The term genetic engineering (**recombinant DNA technology** and **biotechnology** **)** was coined in 1919 by Karl Ereky, a Hungarian engineer. At that time, the term included all the processes by which products are obtained from raw materials with the aid of living organisms.

Nowadays, **genetic engineering** is defined as **any technological application (a set of techniques) that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use**.

Genetic engineering is the direct modification of an organism’s genome, which is the list of specific traits (genes) stored in the DNA. Changing the genome enables engineers to give desirable properties to different organisms. Organisms

created by genetic engineering are called genetically modified organisms (GMOs).

Historical events associated with genetic engineering:(للاطلاع فقط)

Providing bread with leaven	Prehistoric period
Fermentation of juices to alcoholic beverages	Prehistoric period
Knowledge of vinegar formation from fermented juices	Prehistoric period
Manufacture of beer in Babylonia and Egypt	3rd century BC
Wine manufacturing in the Roman Empire	3rd century AD
Production of spirits of wine (ethanol)	150
Vinegar manufacturing industry	14th century AD
Discovery of the fermentation properties of yeast	1818
Description of the lactic acid fermentation by Pasteur	1857
Detection of fermentation enzymes in yeast by Buchner	1897
Discovery of penicillin by Fleming	1928
Discovery of many other antibiotics	≈1945

An overview of important events in the development of modern molecular biology and recombinant DNA technology is provided in Table below:

Double helix structure of DNA is first described by Watson and Crick	1953
Cohen and Boyer, amongst others, develop genetic engineering	1973
The first human protein (somatostatin) is produced in a bacterium *(E. coli)*	1977
The first recombinant protein (human insulin) approved for the market	1982
Polymerase chain reaction (PCR) technique developed	1983
Launch of the Human Genome Project	1990
Began to sell genetically modified food	1994
Began to sell GMOs as pets (Glofish)	2003
The first genome sequence of an organism *(Haemophilus influenzae)* is determined	1995
A first draft of the human genome sequence is completed	2000

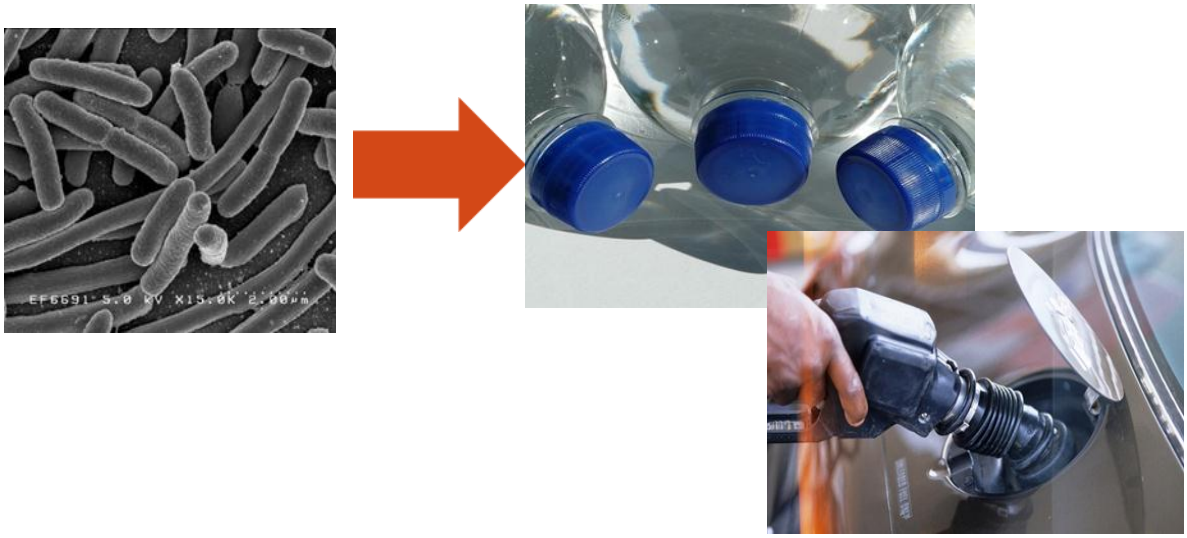
Over 40 million gene sequences are deposited in GenBank, and genome sequences of hundreds of prokaryotes and dozens of eukaryotes are finished or in draft stage

Applications of genetic engineering

The following sections briefly describe some of these applications and their potential benefits to society.

1- Industry

Bacteria are the most common GMOs because their simple structure permits easy manipulation of their DNA. One of the most interesting uses for genetically modified bacteria is the production of hydrocarbons (plastics and fuels) usually only found in fossil fuels. Cyanobacteria have been modified to produce plastic (polyethylene) and fuel (butanol) as byproducts of photosynthesis. *E. coli* bacteria have been modified to produce diesel fuel



2. Health and medicine

In the area of health and medicine, genetic engineering has numerous and important functions. Genetic engineering is used to develop diagnostic tools for identifying diseases.

Genetic engineering is also used to produce more effective and efficient vaccines, therapeutic antibodies, antibiotics, and other pharmaceuticals.

Figure 1: Modified virus injected in sapling tree causes the bananas to contain virus proteins

3. Environment

Development and usage of alternative fuels that burn cleaner and improve air quality through reduced pollution of the environment is possible by genetic engineering means. Micro-organisms are used to decompose wastes and clean up contaminated sites by the technology of bioremediation. The use of disease-resistant cultivars can make crop production less environmentally intrusive by reducing the use of agrochemicals.

4. Forensics

Since the DNA profile, i.e. the nucleotide sequence of the genome, is unique in every individual, it can be used as a powerful basis of identifying individuals in a population. DNA-based evidence is used in cases involving paternity disputes and family relationships. Forensic experts use DNA profiling to identify suspects in criminal cases, especially when body fluids and other particles like hair and skin samples can be retrieved.

5. Agriculture

Genetic engineering can complement conventional breeding for crop and animal improvement. Instead of extensive re-arrangement of genes, as occurs in conventional breeding, biotechnology enables targeted gene transfer to occur. The genome of the recipient individual remains intact, except for the introduced gene (or genes), thus accelerating breeding programs and the development of organisms with desirable characteristics. This biotechnological application is

used to improve the yield of crop and animal species and their product quality such as nutritional value and shelf life.

Figure 2: Reasons to Genetically Modify Crops, Insect resistant, Herbicide resistant, Drought/freeze resistant, Disease resistant, Higher yield, Faster growth, Improved nutrition & Longer shelf life.

Figure 3: Fast-Growing Salmon, Genes from two other fish cause this salmon to continually produce growth hormones.

Genetic modification can be completed by a number of different methods:

1-Inserting new genetic material randomly or in targeted locations

2-Direct replacement of genes (recombination)

3-Removal of genes

4-Mutation of existing genes

Genetic engineering include the collection of a wide array of techniques that alter the genetic constitution of cells or individuals by selective removal, insertion, or modification of individual genes or gene sets, the techniques used for this purpose include:

Gene cloning: the development of a line of genetically identical organisms which contain identical copies of the same gene or DNA fragments

Gene therapy: the insertion of a functional gene or genes into a cell/tissue/organ to correct a genetic abnormality.

PCR: abbreviated from polymerase chain reaction, an in vitro process by which specific parts of a DNA molecule or a gene can be rapidly made into millions or billions of copies within a short time.

Recombination DNA: a hybrid DNA molecule created in the test tube by joining a DNA fragment of interest with a carrier.

DNA Southern blot: a procedure that is used to transfer DNA from a gel to a nylon membrane, which in turn allows the finding of genes that are complementary to particular DNA sequences called probes.
Together, these techniques and others are known as **Genetic engineering** (**recombinant DNA technology**).