Genetic Solution

Genetic engineering applies technologies for manipulating and transferring DNA between separate organisms. It enables the improvement of animal and plant species, the correction of defective genes, and the production of many useful compounds. For example, some microorganisms are genetically modified to manufacture human proteins, which are vital for those who do not produce them efficiently.

Genetic Engineering

Genetic recombination consists of integrating DNA from different organisms. For example, a plasmid is used to insert a known portion of human DNA into the DNA of bacteria. The bacteria then incorporate new genetic information into their chromosomes. When their own DNA is transcribed, the new DNA is transcribed as well. Thus, the bacteria formulate both their own proteins and foreign proteins, such as human insulin.

1 Extraction

DNA is extracted from a human cell to obtain the gene that codes for producing insulin. The DNA is cut using restriction enzymes that recognize the points where the gene in question begins and ends. These enzymes also cut the bacterial plasmid. The DNA fragments thus obtained have irregular and complementary ends.

HUMAN CELL
Each body cell has genetic information distributed among the genes in the nucleus.

NUCLEUS

INSULIN GENE
The DNA sequences for producing insulin are inserted separately into different plasmids.

BACTERIAL PLASMID

MODEL ORGANISMS
Besides *E. coli*, eukaryote cells such as yeast are used.

2 Union

The human and bacterial DNA join at their free ends and form a recombined plasmid. This plasmid contains the human insulin gene.

RECOMBINED PLASMID WITH HUMAN DNA

ROUND CHROMOSOME

BACTERIAL PLASMID

BACTERIA
Escherichia coli contain plasmids (DNA molecules that are separate from chromosomal DNA).

3 Insertion

A culture of nonpathogenic receptor bacteria is placed in a solution that contains the recombined plasmid. The solution is then subjected to chemical and electrical stimuli to incorporate the plasmid that contains the insulin gene.

RECOMBINANT DNA
The recombined plasmid is inserted into the receptor bacteria.

EXTRA DNA
The plasmids may contain up to 250,000 nitrogenous bases outside the chromosome.

10 HOURS
are needed for the culture population to double.

INSERTION INTO THE CHROMOSOME
The recombined plasmid is inserted into the bacteria's chromosome.

NEW INSULIN
The transcription of human DNA enables the formation of recombined human insulin.

4 Reproduction

The bacteria reproduce constantly in fermentation tanks with water and essential nutrients. In these conditions, the recombined bacteria transcribe the information in their chromosomes to produce proteins. The bacteria also read the information from the human DNA that was inserted using the recombined plasmid, and they produce insulin.

BACTERIA
In phase of exponential growth. From now on, they will produce the hormone insulin.

5 Purification

The culture is circulated at high pressure through tiny tubes that destroy the bacteria. The solution contains a large amount of insulin that must be separated from the other proteins in the solution.

HIGH PRESSURE

TINY TUBE

CELLULAR REMAINS

INSULIN

First Case

Insulin was the first protein produced by genetic engineering. It was approved for human use in 1982.

INSULIN PROTEIN

6 Centrifugation

Centrifuges separate the various compounds present in the solution from the bacterial remains and the human insulin. The proteins present in the solid matter are separated from the original solution.

GLASS TUBES

CENTRIFUGAL FORCE
Centrifugal force accelerates the decantation.

DECANTATION
The centrifuges reduce the amount of time necessary to separate the solid matter.

BEFORE CENTRIFUGATION

Insulin in bacterial batch

AFTER CENTRIFUGATION

The separated material that contains bacterial remains.

Insulin pellet

7 Formulation

The recombinant human insulin is chemically modified. This produces a stable, aseptic compound that can be administered therapeutically via injection.

recombinant antibiotics and vaccines
ARE ALSO PRODUCED BY GENETIC ENGINEERING.