

Recombinant Insulin

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Abstract

*Recombinant insulin, a revolutionary product of biotechnology, has transformed the landscape of diabetes treatment. Developed through genetic engineering techniques, recombinant insulin offers a safer, more consistent alternative to traditional animal-derived insulin. Its production involves the insertion of the human insulin gene into host organisms such as *Escherichia coli* or *Saccharomyces cerevisiae*, which serve as efficient factories for insulin synthesis. Recombinant insulin is used to treat diabetic patients who are allergic to beef or pork insulin. This form of insulin is made from recombinant DNA technology that is similar to human insulin. As a consequence, allergy reactions in humans are not very severe. This insulin produced is manufactured and then purified. It is a boon for diabetic patients. One of the key advantages of recombinant insulin lies in its molecular identity to endogenous human insulin, ensuring improved efficacy and reduced risk of adverse reactions. Additionally, recombinant insulin enables precise dosing and customization of treatment regimens through the development of insulin analogs with varied pharmacokinetic properties. The widespread adoption of recombinant insulin has significantly enhanced diabetes management outcomes, leading to better glycemic control and decreased risk of complications. Furthermore, its scalable production and cost-effectiveness have contributed to increased accessibility to essential insulin therapy worldwide. In conclusion, recombinant insulin represents a pivotal advancement in diabetes care, offering a potent combination of biotechnological innovation and medical progress. Further research and development in this area will improve insulin therapy, which looks set to ultimately improve the lives of millions of people with diabetes.*

Keywords: Insulin, diabetes, recombinant DNA technology, recombinant insulin, genetic engineering

INTRODUCTION

The pancreas secretes the important hormone insulin which allows our body to use sugar (glucose), from the carbs in our diet to store for energy or for later use. This is a polypeptide hormone containing 51 amino acids in 2 polypeptide chains. Chain A consists of 30 amino acid while chain B consists of 21 amino acids and both are linked by disulphide bonds. The hormone insulin helps regulate blood sugar levels by preventing blood sugar from going too high, or too high, or too low, or too low [1].

The cells of our body need sugar for energy but sugar cannot go directly in most of the cells of the body. When we eat food our blood sugar level rises and then the beta cells present in the pancreas are signaled to release insulin into the blood stream. Insulin binds to cells and stimulates the uptake of blood sugar.

When there is more sugar in the body than the actual amount needed then this sugar is stored in the liver with the help of insulin and used when our blood sugar level is low or when we need more

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sugar like during exercise or any other physical activity or between our meals.

Diabetes is a disorder resulting from improper carbohydrate intake and high blood glucose levels in which the body is unable to produce or react to insulin. It has two main modes: type 1 and type 2.

People suffering from diabetes need artificial insulin, so their blood sugar level is maintained. Various methods were developed to maintain the blood sugar level. Cattle and pigs were the source of the first insulin used to treat diabetes in humans. Until 1980 animal insulin was the only option to treat diabetic patients who were dependent on insulin. Animal-derived insulin was isolated from the pancreas of animals typically swine (rat or porcine insulin) and bovine (bovine or bovine insulin). After extraction the insulin was purified for the use of patients [2].

RECOMBINANT INSULIN OVER ANIMAL INSULIN

- The drug has been evicting immune response in many patients although bovine and porcine insulin are similar to human insulin there composition is slightly different because of which patients immune system produce antibodies as a result there were allergic reaction and swelling in the body.
- The slaughtered animals produce very little insulin where as demand was very high which could not be fulfilled moreover contamination of this insulin was quite common.
- Because of these reasons these days the use of animal insulin has been replaced by recombinant insulin.
- It is the first commercial biotech product. Because of the discovery of various restriction enzyme and advancement in recombinant DNA technology the formation of recombinant insulin was made possible.
- Recombinant insulin is made by the technology known as recombinant DNA technology.

WHAT IS rDNA TECHNOLOGY?

Scientists have developed a technique called recombinant DNA that allows a human gene to be inserted into the genome of a living bacterium. Consequently, these mutated microorganisms can produce the protein encoded by the human gene [3]. Several scientists have unearthed a method known as recombinant DNA, enabling the insertion of a human gene into the genome of a residing bacterium.

Ultimately, those altered microorganisms have the functionality to generate the protein targeted with the aid of the human gene, which is applied inside the treatment of diabetic patients with hypersensitive reactions to animal insulin. Recombinant DNA era has been applied to supply recombinant insulin the use of both yeast and bacteria.

PROCESS OF FORMATION OF RECOMBINANT INSULIN

One method of manufacturing insulin is to separately grow the 2 insulin chain. This approach requires two smaller genes, one for the A chain and one for the B chain, to avoid the need for a specific enzyme for gene construction using an amino acid sequencing machine of each subunit DNA as already known the exact DNA sequence of each chain.

Then, these two DNA molecules join together to form plasmids, which are small, circular pieces of DNA that fit more heavily into the host's genome.

The manufacturers first introduce the plasmids into a harmless strain of E. coli. These plasmids are inserted next to the lacZ gene encoding the enzyme β -galactosidase. Because this gene can be easily modified, it is widely used in DNA recombinant technology. This facilitates insulin release and prevents it from binding to the bacterial DNA. Methionine, the initiating amino acid for protein synthesis, is located next to the lacZ gene [4, 5].

Recombinant plasmids are now integrated into bacterial cells. Infection and the mechanism of transfer of plasmids into bacteria. To attach a plasmid to the DNA of a bacterium, manufacturers can add an enzyme called DNA ligase, which acts like glue.

Then, insulin-producing bacteria pass through the pipeline. These bacteria are grown in large tubes in production facilities at room temperature, and divided every 20 minutes or so to obtain cells containing the insulin gene.

Once the DNA recovery dose is performed, the cells are removed from the tubes. A popular approach is to first add to a mixture containing lysosomes, which are enzymes that break down the outer layer of the cell wall. Then, a mixture of detergents is added, dissolving the lipid layer of the cell wall. The viral DNA is then exposed to a chemical called cyanogen bromide, which cleaves the protein chain at the methionine residue and separates the insulin chain from the rest of the DNA.

The two chains are then connected by disulphide bonds through the reduction and oxidation processes. The introduction of an oxidizing agent promotes oxidation or electron transfer. The mixture is then placed in a centrifuge, a machine that rotates rapidly to separate cell components by size and weight.

Chromatography and several separation methods that take advantage of differences in the charge, size and water affinity of the molecule are used in the purification process to isolate insulin chains from DNA mixtures. Various techniques are used, including gel filtration chromatography, reverse-phase high-performance liquid chromatography, and ion-exchange chromatography and the insulins are then tested for possible *E. coli* production. They make sure there is no *coli* protein. Labeling proteins are used to identify *E. coli* DNA to confirm the bactericidal success of the purification process [6, 7]. Figure 1 depicts the formation of recombinant insulin using recombinant DNA technology.

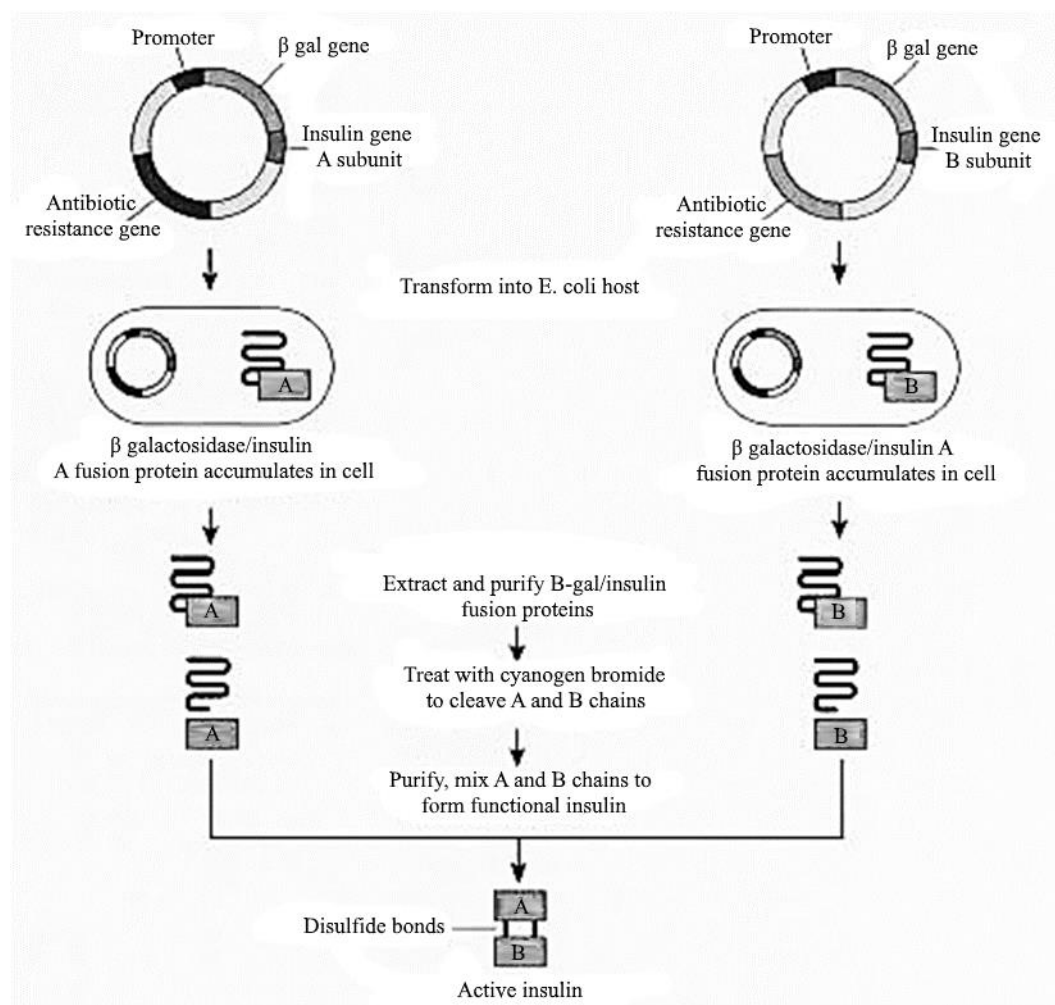


Figure 1. Production of recombinant Insulin [8].

Proinsulin Technique

Except that the proinsulin gene was synthesized from the amino acid pathway, most of the steps in this pathway were the same as for the A-B chain DNA encoding proinsulin was injected into nonpathogenic E. coli bacteria in 1986, and the work began. During fermentation, the bacteria synthesize proinsulin, which is then converted to pure insulin by the fusion of the A and B chains [9].

A number of ingredients are added to insulin at the end of the manufacturing process to prevent bacterial growth. Manufacturers have also produced certain drug delivery devices such as jet-injectors and pens and researcher are also exploring other drug delivery devices to inject.

ADVANTAGES AND DISADVANTAGES OF RECOMBINANT INSULIN

Advantages of Recombinant Insulin

- Recombinant insulin is identical to human insulin that is produced in the pancreas and therefore is very less allergic to diabetics.
- Since yeast and bacteria reproduce very fast and in large amount with less resources hence large quantity of insulin can be produced at the same time. The supply of insulin produced by bacteria is considered to be unlimited according to International Diabetes Federation.
- Recombinant insulin produced is comparatively more pure as purification techniques are performed after this insulin is made and hence no contamination.

- Another benefit of this insulin is that those people who could not use pork insulin or beef insulin because of ethical or religious belief or vegetarianism could use recombinant insulin without any hesitation.
- Recombinant insulin is considered better as it absorbed faster than animals derived insulin and thus it shows his effectiveness in a shorter duration [10].

DISADVANTAGE OF RECOMBINANT INSULIN

- One disadvantage is that some diabetic complain about the increase in episode of hypoglycemic complication.
- While a very few had allergic reactions to recombinant insulin.

CONCLUSION

An important step in modified, regulated, commercial, and even sociopolitical medicine was taken with the introduction of recombinant insulin. It led to a breakthrough in biotechnology combined with the considerable wealth of a pharmaceutical partner. It demonstrated the ideas that caught the attention of big pharmaceutical companies, and led to the acquisitions and acquisitions that fueled the rise of biotechnology. Researchers are trying to fix mutations in the insulin gene, to allow diabetics to produce insulin naturally [11]. Furthermore, the production of insulin via recombinant DNA technology represented a dramatic shift from conventional methods of producing the hormone, which relied on its extraction from animal pancreases and frequently resulted in shortages and allergies in certain patients. Through the use of biotechnology, scientists were able to create microorganisms that could produce human insulin by introducing the insulin gene into their DNA.

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