

# APPLICATION OF RECOMBINANT DNA TECHNOLOGY FOR THE DEVELOPMENT OF VACCINES IN THE FIELD OF VIROLOGY – AN OVERVIEW

## Abstract

The application of recombinant DNA technology in the creation of vaccines has completely changed how we treat infectious diseases. Molecular-level vaccine design and development are made possible by the instruments and processes made possible by biotechnology. This makes it possible to trigger an immune response against particular infections in a more focused and efficient manner.

To elicit an immune response, pathogen antigens can be recognized, separated, and incorporated into a host organism using methods like genetic engineering and recombinant DNA technology. As a result, several vaccine kinds have been created, such as DNA vaccines, subunit vaccinations, and more recently, mRNA vaccines. Furthermore, biotechnology alongside recombinant DNA technology allows for the rapid design and production of vaccines, which is particularly crucial in the face of emerging infectious diseases. The COVID-19 pandemic serves as a prime example of this, where rDNA technology and biotechnology played a pivotal role in the rapid development of effective vaccines. This article mainly focuses how the application of rDNA technology paved way in the production of vaccines against Hepatitis B virus, Influenza virus and Human Papillomavirus with the key points like process and proteins involved.

In conclusion, the application of recombinant DNA technology in vaccine design holds immense potential in advancing global health by providing effective and rapid solutions to combat infectious diseases.

**Keywords:** Recombinant DNA, Vaccines, Virology.

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## **I. INTRODUCTION**

Recombinant DNA technology is a leading modern innovation in the field of science with considerable applications in various areas, including vaccinology. Recombinant DNA technology involves the manipulation of the desired genes using laboratory techniques and certain enzymes. This involves obtaining the gene of interest and copying it by inserting it in a vector or integrating it into a susceptible cell to get its functional product. This technique is widely used to produce hormones and other products. It has also entered the field of vaccinology, where it has been used to express specific proteins and antigenic components to successfully generate a vaccine that can elicit an immune response in humans.

## **II. RECOMBINANT VACCINE DEVELOPMENT AGAINST THE HEPATITIS B VIRUS**

The Hepatitis B virus, a blood-borne pathogen, can cause various illnesses ranging from moderate jaundice to severe hepatic cirrhosis, leading to hepatocellular carcinoma. Due to the virtue of the pathogen going unrecognised in some patients as an asymptomatic illness, the diagnosis of HBV is of major concern. To overcome the severity of the infection, a vaccine was developed that could elicit a proper immune response and prevent the disease progression to seriousness. The vaccine was first developed by William Ruttler, Pablo Valenzuela, and their colleagues via recombinant DNA technology (1). Gene S, from the genome of HBV, which codes for HBsAg, has three in-frame start codons that produce HBsAg proteins in three different sizes (small, medium, and large). It is believed that the large HBsAg protein, the most prevalent form of the surface proteins of HBV infectious viral particles, plays a vital role in the binding of HBV to hepatocytes. With an idea based on recombinant insulin and growth hormone production, HBsAg was successfully cloned into *Escherichia coli* expression vectors by Rutter and his colleagues, proving that recombinant HBsAg might be used as an HBV vaccine. This was their first attempt to develop the vaccine (1). Later, in 1982, Rutter and colleagues from the University of Washington used yeast expression vectors to clone the HBsAg protein. With the aid of a plasmid that put the coding sequence under the control of a constitutive yeast promoter, they produced a significant amount of HBsAg, which was confirmed by immunoassays. Surprisingly, sedimentation and electron microscopy investigations revealed that the major type of HBsAg released by the converted yeast cells, identical to virus-infected human cells, was 22 nm particles. The yeast-produced particles were recognised by the HBsAg-specific antibodies at the time, just like the human cell-derived 22 nm HBsAg particles, which had been demonstrated to be 1,000-fold more immunogenic than the unassembled HBsAg protein (2,3). This was a breakthrough in the field of vaccinology. This allowed large-scale production of HBV vaccines and created a blueprint to produce vaccines against other pathogens.

## **III. RECOMBINANT VACCINE DEVELOPMENT AGAINST INFLUENZA**

Influenza is a disease of global concern. Influenza is known to cause mild to moderate respiratory illness that can turn into severe acute respiratory distress syndrome based on the host's immune response. Although there are treatment protocols in place, vaccines are also available to help boost the immune response upon infection. The vaccines currently available in the market are either cell-based or egg-based vaccines. The drawback of such vaccines is the cost of production or allergic reactions to egg components. The immune response elicited

by the available vaccines is not up to the mark, and the vaccine's efficacy is questionable. This problem has been solved using rDNA technology. The new approach uses various expression systems to produce individual viral proteins that form the subunit vaccine targeted to elicit an immune response to the viral proteins. One such approach is the production of influenza antigenic proteins through insect cell lines and delivering it through the baculoviral vectors. The most widely employed is the *autographa californica* multiple nucleopolyhedrovirus (AcMNPV). For experiments with AcMNPV, Sf9 cell lines derived from *Spodoptera frugiperda* ovarian tissue are frequently employed. Different influenza A viral antigens can be produced using this technique. High antibodies that can neutralise the influenza H5N1 virus were induced in mice after immunising with the recombinant HA utilising the baculovirus expression technique (4). An adjuvant or prime-boost immunisation using an inactivated influenza H5N1 virus or the recombinant adenovirus bearing the influenza virus's HA gene was necessary to achieve any meaningful antibody level.

#### **IV. RECOMBINANT VACCINE DEVELOPMENT AGAINST HUMAN PAPILLOMAVIRUS**

Human papillomavirus, abbreviated as HPV, is a DNA virus responsible for various diseases in the human population, especially women. They are known to cause genital warts, leading to cervical cancer in females. There are subtypes of HPV categorised into low-risk and high-risk groups based on its ability to persist in the host and its likeability to cause cervical cancer. It is known that HPV serotypes 16 and 18 are known to be high-risk as they account for 77% of cervical cancer in India (5). This led to a keen interest in developing a vaccine against HPV. Two vaccines are licenced and currently available in the global market: Gardasil (Merck) and Cervarix (Glaxo Smith Kline). The L1 main capsid protein of HPV is expressed via recombinant DNA technology in yeasts (*Saccharomyces cerevisiae*), which self-assemble to form empty shells mimicking viruses, known as virus-like particles (VLPs). The VLPs lack genetic material but have the same exterior L1 protein coat as HPV. These VLPs serve as antigens in the vaccination, which triggers a potent immune response that is protective. Gardasil is a quadrivalent vaccine with VLPs from 4 serotypes – 16, 18, 6 and 11. In comparison, Cervarix is a bivalent vaccine with VLPs from serotypes 16 and 18 (5).

#### **V. CONCLUSION**

Recombinant DNA technology has been by far the most applied field of study for the development of science. Its application in the field of vaccinology has expanded the knowledge of microbes and led to many improved vaccines and antigenic compounds. Currently, thousands of vaccines are in development thanks to rDNA technology, which has eased the path to eradicating or controlling various deadly diseases.

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