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Significance of Incorporating Biotechnology in Vaccine Development

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Timely vaccination helps people to live a healthy life with no infectious diseases. Agents in vaccines are derived by inactivation of microbes, which may also contain subunits, e.g. parts of surface antigens, or toxins. In the past years, a number of new biotechnological methods have been added to the development of vaccines that have revolutionized the conventional practices. Biotechnology and its development and use have led to immense diversification of the clinical outcomes and strategies of healthcare. The occurrence of contagious diseases has decreased in the contemporary world; non infectious diseases on the other hand are on the increase and they present a significant burden to the healthcare systems of the world at large. Biotechnology is providing solutions that are promising to the prevention of the infectious diseases and to the features of non-infectious diseases [1].

It is critical to comprehend the importance of vaccines before discussing the importance of biotechnology in vaccine development. Although there is an improvement in medicine, some of the deadliest pathogens in the world such as malaria and HIV are yet to have vaccines in place [2]. Vaccines are biological agents that are used to boost the immune system against bacterial or viral infections, and as a result, prevent diseases proactively. They usually include inactivated pathogens or certain antigenic constituents, usually those of surface-binding proteins of the pathogens. These antigens, when introduced into the body, induce the immune system to react to the respective pathogen efficiently equipping the body with defence against possible infections in future [1,2].

Biotechnological approaches such as genetic engineering and cell culture are contemporary technologies that have transformed vaccine production. Such techniques can be used to create vaccines which are easier to manufacture, less expensive and can produce more robust and sustained immunity. Prevention of infectious diseases and promotion of patient outcomes is the main aim of applying biotechnology in the development of vaccines [1]. They involve the insertion of desired genes into plants or body cells and the production of the encoded proteins. These genetically engineered vaccines make the body more immune even in situations when conventional vaccines and treatment methods have failed, and this leads to hope of recovery of serious and persistent illnesses. Biotechnology has played out in three main ways per majorly in generating specific monoclonal antibodies, application of cloned genes to produce antigens and synthesis of peptides which may be used as vaccines.

Reverse vaccinology is one of the most important innovations in the field in which biotechnology holds a key position in changing the research on vaccines. Reverse vaccinology refers to the process of cloning and genome analysis of entire pathogenic genomes by applying bioinformatics tools in a proactive fashion with the intent of identifying targets that would be the basis of vaccines. DNA microarrays, proteomics and comparative genome analysis are functional genomic techniques used to discover virulence factors and promising vaccine targets. Although reverse vaccinology was originally developed to make MenB vaccines, this technology has now been applied to other bacterial vaccines, including Staphylococcus aureus and Streptococcus pneumoniae [3]. The antigens can be predicted using modern computational techniques without paying attention to their abundance or immunogenicity, which offers a more accurate and effective approach to developing vaccines.

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Biotechnology has further enhanced the quicker velocity in creating vaccines to emerging pathogens. As an example, the COVID-19 pandemic emphasized the urgency to make vaccines as quickly as possible. Biotechnological tools helped develop effective vaccines in a several months, compared to traditional vaccine development which would have taken years to develop. Such technologies like mRNA vaccines, viral vectors vaccines and recombinant protein vaccines demonstrate how biotechnology can be used directly to offer new and effective responses during a crisis in the life of the people. In addition to infectious diseases, biotechnology has the prospects of employing non-infectious diseases like some types of cancers by developing therapeutic vaccines which induce immune responses against cancerous cells [2,3].

Biotechnology is a necessity of contemporary vaccinology. Its use in vaccine development can integrate the process of quick, accurate, and effective vaccine manufacturing and improve the health outcomes of the population at a global level. Biotechnology deployment in strategic innovation of vaccines is not only crucial in tackling the current infectious hazards, but also providing a remedy of the diseases that could not be treated before or controlled effectively. With an ever-growing development of scientific skills, biotechnology in vaccinology will have an increased role to play to make the global health issues safer, efficient, and comprehensive in prevention efforts.

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