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Advancements in Prokaryotic and Eukaryotic Expression Systems for Viral Antigen Production in Vaccine Development Post-Pandemic

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Introduction

The COVID-19 pandemic underscored the importance of rapidly developing vaccines to combat emerging infectious diseases. Vaccine production, particularly in response to novel viral threats, relies heavily on the efficient production of viral antigens. These antigens, which are proteins derived from the virus, stimulate the immune system to mount a protective response without causing disease. The ability to produce high-quality, large-scale viral antigens is pivotal for the successful development of vaccines, and the choice of expression system plays a critical role in this process. Prokaryotic and eukaryotic expression systems are the two most commonly used platforms for producing viral antigens for vaccine development. Both systems offer distinct advantages and limitations based on the complexity of the antigen, the need for post-translational modifications, and the scale of production. The advancements in these expression systems, particularly in the wake of the COVID-19 pandemic, have dramatically improved the speed, efficiency, and scalability of viral antigen production. These systems are favored for their simplicity, rapid growth, and relatively low cost. In the context of viral antigen production for vaccines, prokaryotic systems are particularly useful for producing antigens that do not require complex post-translational modifications, such as glycosylation. However, producing complex viral proteins in prokaryotic systems poses several challenges, including the risk of incorrect folding or formation of inclusion bodies. Despite these limitations, significant advances have been made to improve the efficiency and functionality of prokaryotic-based systems for viral antigen production [1,2].

Description

Prokaryotic expression systems, particularly E. coli, can produce large amounts of protein in a short period of time. The growth rate of bacteria is extremely fast, with cultures doubling every 20 minutes, making them ideal for rapid production. In the context of viral vaccines, this rapid production is critical when dealing with emergent infectious diseases. E. coli and other prokaryotic organisms are inexpensive to culture, and the production process is highly cost-efficient. This is particularly important in the context of pandemic response, where large quantities of vaccine antigens must be produced quickly and economically. Prokaryotic systems are genetically tractable, meaning that researchers can easily manipulate the organism's genetic code to express viral antigens. This includes cloning the gene for the viral antigen of interest into a plasmid vector and inducing its expression. E. coli often expresses recombinant proteins in the form of inclusion bodies, which are aggregates of misfolded proteins. This can complicate the purification process and reduce the yield of functional protein. One solution to this problem is the use of engineered prokaryotic strains that can mimic eukaryotic glycosylation pathways, although these systems are still in development [3-5].

Conclusion

One of the most promising advancements in eukaryotic expression systems is the development of cell-free expression systems. These systems allow for the synthesis of proteins without the need for living cells. By providing the necessary cellular machinery in a test tube, researchers can produce viral antigens more quickly and with less complexity. This method is still in its early stages but has the potential to revolutionize the speed and scalability of antigen production, particularly in response to pandemics. The rapid response to the COVID-19 pandemic highlighted both the strengths and weaknesses of existing viral antigen production systems. The demand for large quantities of high-quality viral antigens pushed the development and optimization of both prokaryotic and eukaryotic expression systems. The lessons learned from the pandemic are likely to have a lasting impact on the field of vaccine development and production. The use of mRNA technology for the production of viral antigens in COVID-19 vaccines, such as those produced by Pfizer-BioNTech and Moderna, revolutionized the speed at which vaccines could be developed and manufactured. mRNA vaccines do not require live cells for antigen production, which significantly reduces production time.

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Conflict of Interest

None.

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