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Developments in Post-pandemic Viral Antigen Production for Vaccines Using Prokaryote and Eukaryote-based Expression Systems

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Introduction

The COVID-19 pandemic underscored the critical need for rapid, scalable, and effective vaccine production technologies. The unprecedented global effort to develop vaccines for SARS-CoV-2 led to significant advancements in viral antigen production, highlighting the capabilities of both prokaryote-based (bacterial) and eukaryote-based (cellular) expression systems. These systems are central to the production of viral antigens, which are crucial components of vaccines designed to induce an immune response. As the world moves beyond the pandemic, the demand for vaccines against emerging infectious diseases remains high, necessitating further improvements in the efficiency and versatility of these antigen production platforms. This article explores the current state of developments in post-pandemic viral antigen production, focusing on the advantages and challenges of using prokaryotic and eukaryotic expression systems [1,2].

Description

Eukaryotic systems can perform complex post-translational modifications, such as glycosylation, phosphorylation, and correct protein folding, making them ideal for producing viral antigens that require these modifications for functionality. For example, the spike protein of SARS-CoV-2, which needs proper glycosylation to maintain its immunogenicity, is often produced in mammalian cells. Eukaryotic expression systems generally produce higher-quality proteins with the correct structure and functionality, which is essential for creating vaccines that effectively stimulate an immune response. Eukaryotic systems can be scaled for large-scale production. Furthermore, they can be engineered to produce a wide variety of proteins, including those that require complex folding or assembly, such as viral vectors used in gene therapy. Challenges Eukaryotic expression systems are typically more expensive and complex to maintain compared to prokaryotic systems. The growth of mammalian cells requires specialized culture media, controlled environments, and more time for the cells to grow and produce proteins. While eukaryotic systems can produce higher-quality proteins, they often yield lower quantities of recombinant protein compared to bacterial systems. This makes the production process more time- and resource-intensive. Mammalian cell cultures are susceptible to contamination from viruses, mycoplasma, or other microorganisms. Maintaining aseptic conditions is crucial for the successful production of viral antigens in these systems. The use of eukaryotic systems in vaccine production often requires extensive regulatory oversight, particularly when mammalian cell cultures are used. This can prolong the time to market and increase the cost of vaccine production [3-5].

Conclusion

Recent technological advancements have enhanced the capabilities of eukaryotic expression systems, particularly in the context of viral antigen production. Cell-free systems, which use purified cellular machinery to synthesize proteins outside living cells, have been developed as a flexible alternative for rapid antigen production. These systems bypass the need for cell cultures entirely, offering faster protein production and reducing some of the complexities associated with traditional eukaryotic systems. Insect cell expression systems, particularly using baculovirus vectors in Sf9 or Sf21 cells, have emerged as a viable alternative to mammalian cell systems. These systems can express large viral proteins efficiently and are often used in the production of viral vaccines, such as those for influenza and Zika virus. Advances in Chinese hamster ovary cell technology have significantly improved their efficiency, both in terms of yield and the quality of produced proteins. New CHO cell lines have been engineered to produce higher yields of recombinant proteins while maintaining correct post-translational modifications, which is critical for the production of complex viral antigens.

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Conflict of Interest

None.

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