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Bioinformatic Strategies for the Production of Glycoproteins in Algae

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Abstract : Biopharmaceuticals represent one of the wildest developing fields within biotechnology, and the biological macromolecules being produced inside cells have a variety of applications for therapies. In the past, mammalian cells, especially CHO cells, have been employed in the production of biopharmaceuticals. This is because these cells can achieve human-like completion of PTM. These systems, however, carry apparent disadvantages like high production costs, vulnerability to contamination, and limitations in scalability. This research is focused on the utilization of microalgae as a bioreactor system for the synthesis of biopharmaceutical glycoproteins in relation to PTMs, particularly N-glycosylation. The research points to a growing interest in microalgae as a potential substitute for more conventional expression systems. A number of advantages exist in the use of microalgae, including rapid growth rates, the lack of common human pathogens, controlled scalability in bioreactors, and the ability of some PTMs to take place. Thus, the potential of microalgae to produce recombinant proteins with favorable characteristics makes this a promising platform in order to produce biopharmaceuticals. The study focuses on the examination of the N-glycosylation pathways across different species of microalgae. This investigation is important as N-glycosylation—the process by which carbohydrate groups are linked to proteins—profoundly influences the stability, activity, and general performance of glycoproteins. Additionally, bioinformatics methodologies are employed to explain the genetic pathways implicated in N-glycosylation within microalgae, with the intention of modifying these organisms to produce glycoproteins suitable for human consumption. In this way, the present comparative analysis of the N-glycosylation pathway in humans and microalgae can be used to bridge both systems in order to produce biopharmaceuticals with humanized glycosylation profiles within the microalgal organisms. The results of the research underline microalgae's potential to help improve some of the limitations associated with traditional biopharmaceutical production systems. The study may help in the creation of a cost-effective and scale-up means of producing quality biopharmaceuticals by modifying microalgae genetically to produce glycoproteins with N-glycosylation that is compatible with humans. Improvements in effectiveness will benefit biopharmaceutical production and the biopharmaceutical sector with this novel, green, and efficient expression platform. This thesis, therefore, is thorough research into the viability of microalgae as an efficient platform for producing biopharmaceutical glycoproteins. Based on the in-depth bioinformatic analysis of microalgal N-glycosylation pathways, a platform for their engineering to produce human-compatible glycoproteins is set out in this work. The findings obtained in this research will have significant implications for the biopharmaceutical industry by opening up a new way of developing safer, more efficient, and economically more feasible biopharmaceutical manufacturing platforms.

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