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Short Communication

Therapeutic Strategies of Glycoengineering in Harnessing the Power of Glycans for Advanced Therapies

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DESCRIPTION

Glycoengineering, the manipulation of glycans on proteins and other biomolecules, has emerged as a powerful approach in therapeutic development. Glycans play critical roles in various biological processes, including cell signaling, immune responses and disease progression. By modulating glycan structures, researchers can enhance the therapeutic properties of biotherapeutics, design novel glycan-based drugs and develop targeted therapies. This article explores the therapeutic strategies of glycoengineering and highlights their potential applications in advanced therapies [1].

Glycoengineering approaches

Glycan remodeling: Glycan remodeling involves modifying the glycan structures on therapeutic proteins to improve their pharmacokinetics and therapeutic efficacy. This can be achieved through enzymatic or chemical methods. Enzymatic glycan remodeling utilizes glycosyltransferases and glycosidases to selectively modify specific glycan residues, leading to altered glycan structures with desired properties. Chemical methods, such as chemoenzymatic approaches, allow the incorporation of non-natural glycan residues into proteins, expanding the repertoire of functional glycans [2].

Glycan masking: Glycan masking involves shielding or masking specific glycans on therapeutic molecules to reduce unwanted interactions or immunogenicity. This approach can be particularly useful for improving the pharmacokinetics and reducing immunogenic responses of protein therapeutics. By strategically placing masking groups, such as Polyethylene Glycol (PEG) or other polymers, over immunogenic glycan epitopes, researchers can extend the circulation half-life and enhance the therapeutic efficacy of biotherapeutics [3,4].

Glycan targeting: Glycan targeting strategies aim to exploit the specific interactions between glycans and their cognate receptors for targeted drug delivery and therapy. By engineering glycan structures on therapeutic molecules, researchers can achieve precise targeting to specific cell types or tissues. For example, tumor-specific glycans can be incorporated into drug delivery systems, allowing selective accumulation and uptake by cancer cells. Additionally, glycan targeting can be utilized to modulate immune responses, such as redirecting immune cells to specific sites or enhancing immune cell activation against pathogens or tumors [5].

Applications of glycoengineering in therapeutics

Antibody therapeutics: Glycoengineering has revolutionized the field of antibody therapeutics by modulating the glycan structures on monoclonal Antibodies (mAbs). Altering the glycan composition can impact antibody effector functions, such as Antibody-Dependent Cellular Cytotoxicity (ADCC) and Complement-Dependent Cytotoxicity (CDC). By optimizing glycosylation patterns, researchers can enhance the therapeutic efficacy and reduce immunogenicity of mAbs. Furthermore, glycoengineering can improve the pharmacokinetics of antibody therapeutics, extending their half-life and reducing dosing frequency [6].

Vaccines: Glycoengineering strategies have been applied to vaccine development to enhance immune responses and broaden vaccine coverage. By incorporating specific glycans or glycan mimetics into vaccine formulations, researchers can improve immune recognition and stimulate robust immune responses. Glycoconjugate vaccines, which consist of carbohydrate antigens covalently linked to carrier proteins, have been successfully developed against bacterial pathogens such as *Haemophilus influenzae* type b and *Streptococcus pneumoniae*. Glycoengineering can also aid in the design of vaccines against viral infections, including influenza and HIV [7].

Cell and gene therapies: Glycoengineering holds great promise in the field of cell and gene therapies. By modifying glycan structures on cell surface receptors or viral vectors, researchers can enhance target cell specificity, improve vector stability and optimize transduction efficiency. For example, glycan modifications on Chimeric Antigen Receptor (CAR) T cells have shown potential in improving their tumor targeting and persistence in cancer immunotherapy. Similarly, glycan

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engineering of viral vectors can enhance their tropism and transduction efficiency in gene therapy applications [8].

Regenerative medicine: Glycoengineering strategies are being explored to improve tissue engineering and regenerative medicine approaches. By modulating the glycan composition on scaffolds or cell surfaces, researchers can enhance cell adhesion, migration and differentiation. This can promote tissue regeneration and improve the integration of engineered tissues with the host. Glycan-based biomaterials and coatings can also provide bioactive cues to guide cell behavior and modulate the inflammatory response in tissue engineering applications [9,10].

CONCLUSION

Glycoengineering has opened up new possibilities in therapeutic development by harnessing the power of glycans. The ability to manipulate glycan structures on therapeutic molecules offers tremendous potential in improving the efficacy, safety, and targeted delivery of biotherapeutics. The applications of glycoengineering span across various therapeutic areas, including antibody therapeutics, vaccines, cell and gene therapies, and regenerative medicine. As the field continues to advance, further exploration of glycoengineering strategies will undoubtedly lead to innovative and more effective therapeutic interventions.

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