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Peptide-Based Therapeutics: Synthesis, Challenges and Therapeutic Potential in Infectious Diseases

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DESCRIPTION

Peptide-based treatments, which have distinct benefits over conventional small-molecule medications and biologics, have become a potential class of medications in the battle against infectious illnesses. These short sequences of amino acids, known as therapeutic peptides, have a variety of biological actions, such as antiviral, immunomodulatory and antibacterial qualities. The synthesis of peptide-based therapies, the difficulties encountered during their development and their possible uses in the management of infectious illnesses are all examined in this article.

Chains of amino acids with two to about fifty residues are commonly referred to as peptides. They function as hormones, neurotransmitters and signaling molecules and are essential to many biological processes. Peptides have become popular therapeutic agents, especially in infectious disorders, because of their capacity to interact with biological targets in a selective manner. Compared to traditional medications, their comparatively low molecular weight and high specificity provide better pharmacokinetics and fewer adverse effects. Antimicrobial Peptides (AMPs), vaccine peptides and therapeutic peptides that boost immune responses are some of the categories into which peptide-based therapies can be divided. For example, naturally occurring peptides called AMPs have broad-spectrum antiviral, antifungal and antibacterial properties. These peptides have attracted a lot of attention in the fight against drug-resistant diseases because they have the ability to damage microbial membranes, which results in cell death.

Solid-Phase Peptide Synthesis (SPPS) is the most widely used process in the synthesis of peptide-based therapies, while there are other approaches as well. Through the progressive addition of protected amino acids to a solid support, SPPS enables the automated and effective assembly of peptides, making it easier to remove protective groups following each coupling step. High yields and purity of peptides may be produced with this approach, which is essential for medicinal uses. Liquid-phase peptide synthesis and recombinant DNA technology are further synthesis techniques besides SPPS. For shorter peptides, liquid-phase synthesis is usually used, which uses conventional chemical coupling techniques. In contrast, recombinant technology enables the production of complex therapeutic proteins by enabling the expression of bigger peptides or proteins in host organisms like yeast or bacteria. Peptide synthesis has advanced however there are still issues. Problems include poor yields, racemization (the transformation of an amino acid into its mirror image) and the production of improper disulfide bonds might result from the intricacy of peptides. Furthermore, many peptides' biological function depends on post-translational modifications, which can be challenging to accomplish in synthetic procedures. Developing successful peptide-based therapies requires optimizing these synthesis techniques.

Peptide-based therapies have a lot of potential, but their research and clinical use are hampered by a number of issues. The stability of peptides is a major obstacle. Because of their intrinsic structural characteristics, peptides can be broken down by protease, which reduces their bioavailability and therapeutic effectiveness. Chemical changes that can improve resistance to enzymatic cleavage, including cyclization or the addition of non-natural amino acids, are examples of strategies to increase stability. Furthermore, peptide therapies' immunogenicity is an important factor. Foreign peptides may cause immunological reactions when they enter the body, which might result in negative side effects or reduced effectiveness. Peptide mimetics, adjuvants to improve immunological tolerance and peptide sequence modifications are methods to reduce immunogenicity.

Peptide-based medicines have a wide range of therapeutic promise in infectious disorders, including immunotherapeutic, antiviral and antibacterial uses. Defensins and cathelicidins are examples of Antimicrobial Peptides (AMPs) that have shown effectiveness against a variety of infections, including those that are resistant to antibiotics. They usually work by breaking down bacteria membranes, which reduces the possibility that resistance would emerge. Peptides have the potential to be used as vaccine candidates in addition to their direct antibacterial action. Infectious illness prevention, for example, may be possible using peptide-based vaccinations that trigger particular immune reactions against bacterial or viral antigens. These vaccines have the potential to boost B-cell and T-cell responses, which would ultimately result in better infection prevention. Immunomodulation also benefits greatly from peptide therapies, especially when viral infections are involved. To strengthen the immune system's defense against particular viruses, peptides made from viral proteins can be used. For instance, T-cell responses can be triggered by therapeutic peptides that resemble viral epitopes, improving the identification and removal of infected cells. This method has showed potential in treating long-term viral diseases like hepatitis B and C.