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Insights from Medicinal Chemistry into Antiviral Peptidomimetics

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Abstract

Infectious diseases have been a major threat to human health throughout history. With the discovery of anti-infective agents, the mortality rate of these diseases has significantly reduced. Anti-infective agents are compounds that inhibit or kill the infectious agents like bacteria, viruses, fungi, or parasites. They are designed to target specific features of these infectious agents to prevent their growth, replication, or survival. Medicinal chemistry plays a crucial role in the development of anti-infective agents. In this article, we will discuss the different types of anti-infective agents, their modes of action, and their medicinal chemistry.

Keywords: Peptide • Peptidomimetic • Antiviral • Drug discovery

Introduction

Antibacterial agents are compounds that specifically target bacteria. They can be further classified into several classes based on their mode of action, such as cell wall synthesis inhibitors, protein synthesis inhibitors, nucleic acid synthesis inhibitors, and membrane disruptors. Bacteria have a cell wall that protects them from the external environment. Cell wall synthesis inhibitors target specific enzymes involved in the synthesis of the bacterial cell wall, resulting in the disruption of the cell wall and ultimately bacterial death. Examples of cell wall synthesis inhibitors include penicillins, cephalosporins, and carbapenems. Protein synthesis is a crucial process for bacterial growth and survival. Protein synthesis inhibitors target the bacterial ribosome, preventing the synthesis of proteins, and resulting in bacterial death. Examples of protein synthesis inhibitors include macrolides, tetracyclines, and aminoglycosides. Nucleic acid synthesis is essential for bacterial growth and survival. Nucleic acid synthesis inhibitors target specific enzymes involved in nucleic acid synthesis, preventing bacterial DNA replication, RNA transcription, or both. Examples of nucleic acid synthesis inhibitors include quinolones, metronidazole, and rifampin. Nucleoside analogs mimic the structure of natural nucleosides, which are the building blocks of DNA and RNA. When incorporated into the viral DNA or RNA, nucleoside analogs disrupt the replication of the virus, leading to viral death. Examples of nucleoside analogs include acyclovir and ribavirin.

Literature Review

Non-nucleoside inhibitors target specific viral enzymes involved in the replication of the virus. They bind to the enzyme and prevent its activity, leading to viral death. Examples of non-nucleoside inhibitors include protease inhibitors and neuraminidase inhibitors. Antifungal agents are compounds that specifically target fungi. They can be classified into several categories based on their mode of action, such as cell wall synthesis inhibitors, ergosterol synthesis inhibitors, and nucleic acid synthesis inhibitor. Like bacteria, fungi also have a cell wall that protects them from the external environment. Cell wall synthesis inhibitors target specific enzymes involved in the synthesis of the fungal cell wall, resulting in the disruption of the cell wall and ultimately fungal death.

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Anti-infective agents are drugs used to treat infections caused by microorganisms such as bacteria, viruses, fungi, and parasites. These drugs have played a crucial role in the treatment and prevention of infections that have caused significant morbidity and mortality throughout history. The discovery and development of new anti-infective agents are of utmost importance in combating emerging infectious diseases and drug-resistant pathogens. In medicinal chemistry, the design and development of anti-infective agents involve a complex process of identifying drug targets, synthesizing and optimizing drug candidates, and evaluating their efficacy, safety, and pharmacokinetic properties. This process requires a deep understanding of the molecular mechanisms of infectious diseases and the pharmacological properties of the drugs that can modulate them.

Discussion

Chitosan, a chitin-derived biodegradable and biocompatible polysaccharide, has been extensively researched as a promising nanovehicle for cancer therapy. Chitosan has shown promise in cancer therapy, particularly as a dissolving agent, drug stabiliser, and controlled-release drug control, providing a multifunctional platform for targeting, stimulus-responsive release, and image-guided medicine. The design criteria for achieving cancer-targeting goals, which include selective targeting of cancer cells, efficient anticancer drug release at target sites, and elimination of cytotoxicity to non-cancerous tissues, will be met by CSNPs. Chitosan has a unique combination of properties that make it a promising option for cancer therapy when compared to other natural polymers such as alginate or gelatin.

One of the most critical aspects of anti-infective drug discovery is identifying suitable drug targets. In bacterial infections, these targets are often enzymes or receptors that are specific to the bacterial cell wall or metabolism. For example, β-lactam antibiotics such as penicillin and cephalosporins target the penicillin-binding proteins (PBPs) that are involved in the synthesis of the bacterial cell wall. Other examples include antibiotics that target the ribosome, such as macrolides and tetracyclines, or those that interfere with bacterial DNA replication or transcription, such as fluoroquinolones and rifampicin.

In viral infections, drug targets are often viral enzymes or proteins that are essential for viral replication or assembly. For example, nucleoside analogs such as acyclovir and tenofovir target the viral DNA polymerase or reverse transcriptase, respectively, inhibiting viral replication. Protease inhibitors such as lopinavir and ritonavir target the viral protease, preventing the maturation of viral particles. Other drugs such as interferons and monoclonal antibodies target the host immune response, stimulating antiviral activity or neutralizing viral particlesl. In fungal and parasitic infections, drug targets are often specific enzymes or metabolic pathways that are unique to the pathogen. For example, antifungal drugs such as azoles and echinocandins target the fungal cell membrane or cell wall, respectively, inhibiting fungal growth. Antiparasitic drugs such as artemisinin and quinine target the parasites' metabolism, inhibiting their replication or killing them directly.

Once drug targets are identified, medicinal chemists must design and

synthesize drug candidates that can effectively modulate these targets while minimizing side effects and toxicity. This process involves the use of structure-based drug design, which utilizes the three-dimensional structure of the drug target to optimize drug candidates' potency and selectivity. In addition, medicinal chemists use various drug design strategies such as scaffold hopping, bioisosteric replacement, and prodrug design to optimize drug candidates' pharmacokinetic properties, such as solubility, bioavailability, and metabolic stability [1-6].

Conclusion

After synthesizing drug candidates, the next step is to evaluate their efficacy and safety in preclinical and clinical studies. Preclinical studies involve in vitro and in vivo experiments to determine the drug's pharmacological properties, such as potency, selectivity, and pharmacokinetics. These studies also evaluate the drug's toxicity and potential adverse effects on various organs and tissues. If the drug candidate shows promising results in preclinical studies, it can proceed to clinical trials. Clinical trials involve testing the drug's efficacy and safety in humans, following a rigorous regulatory framework to ensure patient safety and ethical standards. Clinical trials involve three phases, with each phase assessing different aspects of the drug's efficacy and safety.

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Conflict of Interest

There are no conflicts of interest by author.

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