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Review Article

The Role Of Stereochemistry And Formulation In Pharmacology Of The Drug

Mohd Sharique Katchhi*, Disha Kumareshi, Harshitha M. V., Chakure Aditya, Abrar Ahmed

Department of Pharmacy Practice, KLE College of Pharmacy, Rajajinagar, Bengaluru, India, 560094.

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ABSTRACT

Stereochemistry profoundly influences the pharmacological properties of various drug classes, including antipsychotics, cardiovascular drugs, antibiotics, and antivirals. This review explores the impact of stereochemistry on drug efficacy, safety, and formulation across these therapeutic categories. Enantiomeric differences in drugs such as citalopram and beta-blockers highlight the significance of selecting the more active stereoisomer for improved clinical outcomes. Advanced drug formulations, including extended-release options and novel delivery systems, offer enhanced convenience and efficacy, particularly in antipsychotic and cardiovascular therapy. In the realm of anticancer drugs, understanding stereochemistry aids in the development of more potent and selective agents, while in antibiotics, it sheds light on mechanisms of action and resistance. Antiviral drug research emphasizes the importance of stereochemistry in optimizing drug design, metabolism, and formulation to combat infectious diseases effectively. Notably, advancements in nanotechnology offer promising avenues for improving antiviral therapies. This comprehensive exploration underscores the critical role of stereochemistry in drug development and optimization across diverse therapeutic areas, shaping the future of pharmacotherapy.

INTRODUCTION

Stereochemistry plays a pivotal role in drug design and pharmacology, influencing the interactions between drugs and biological systems. The spatial arrangement of atoms in a molecule impacts its pharmacological properties, affecting factors like potency, selectivity, and toxicity. Formulation also significantly influences drug behavior in the body, impacting absorption rates, bioavailability, and stability. Understanding the stereochemical configuration of drugs is crucial for optimizing their therapeutic effects while minimizing adverse reactions. By considering both stereochemistry and formulation in drug development, researchers can tailor medications to enhance efficacy and safety profiles.

***Corresponding Author:** Mohd Sharique Katchhi
Address: *Department of Pharmacy Practice, KLE College of Pharmacy, Rajajinagar, Bengaluru, India, 560094.*
Email ✉: mohammadsaadshaikh400@gmail.com

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ANTI PSYCHOTIC DRUGS

Stereochemistry exerts a profound influence on the pharmacological properties of antipsychotic drugs, shaping their efficacy, tolerability, and safety. The presence of chiral centers in these drugs often results in the formation of enantiomers, non-superimposable mirror images of each other. Racemic mixtures, comprising equal proportions of these enantiomers, are commonly encountered in drug formulations (Baker et al., 2002). However, the distinct pharmacodynamic and pharmacokinetic properties of enantiomers can lead to varied clinical outcomes, including adverse reactions, differences in rates of metabolism and clearance, and altered interactions with metabolic enzymes and other drugs (Howland 2009). In the specific context of antipsychotic drugs, examples such as citalopram highlight the relevance of chirality. Citalopram, an antidepressant with anti-anxiety properties, is presented as a racemic mixture. The S-enantiomer, escitalopram, exhibits at least twice the potency in inhibiting serotonin reuptake compared to the racemic form. This not only allows for lower effective doses but also contributes to an improved therapeutic index, safety profile, and reduced drug interaction liability. The clinical implications of such stereochemical differences are profound, influencing dosing strategies and overall therapeutic efficacy (De et al., 2002). The pharmacological significance of stereochemistry is underscored by the case of citalopram, where the separation of the more potent enantiomer, escitalopram, from its less potent counterpart, R(−)-citalopram, has been instrumental. The ability to isolate the active stereoisomer has paved the way for a more targeted and efficient treatment approach. Escitalopram, with its enhanced pharmacological profile, holds promise as an effective and well-tolerated antidepressant (Burke et al., 2002). Regulatory bodies like the U.S. Food and Drug Administration encourage an emphasis on stereochemistry in drug development, as reflected in ongoing research and advancements in understanding the fate of chiral psychotropic agents (Howland 2009). The intricate interplay of chirality in antipsychotic drugs is a critical factor influencing their therapeutic outcomes. The selective use of stereochemically pure drugs, focusing on the more active enantiomer, can lead to improvements in treatment efficacy and patient safety. Continued research in the field of stereochemistry promises to unravel further complexities, offering insights into dose-response relationships and the impact of various factors on the stereoselective pharmacokinetics and pharmacodynamics of antipsychotic drugs (Baker et al 2002). In the realm of antipsychotic drugs, advancements in drug formulations have significantly influenced their pharmacological impact. The introduction of extended-release formulations for once-daily or even once-weekly administration, orally disintegrating tablets, and transdermal systems has transformed the landscape of antipsychotic therapy. Long-acting central nervous system stimulants designed for attention deficit hyperactivity disorder have mitigated the need for multiple dosing, enhancing patient compliance. Specifically within the domain of atypical antipsychotic agents, novel formulations such as rapid-acting intramuscular injections, liquid formulations, and fast-dissolving tablets have emerged as valuable options, particularly in acute treatment settings and for diverse patient populations, including geriatric and pediatric groups (Keith 2006). These innovative formulations offer advantages over traditional ones in terms of convenience, improved side-effect profiles, enhanced efficacy, and faster onset of action. The importance of dosage forms in achieving successful pharmacotherapy is underscored, with specialized formulations addressing specific patient needs. An example is the orally disintegrating formulation of the

antidepressant mirtazapine, catering to patients with difficulty swallowing tablets (Frijlink 2003). Additionally, slowrelease formulations (SRFs) have been developed based on the premise that the pharmacological response is closely tied to changes in plasma concentrations. While SRFs are considered bioequivalent to immediate release formulations for drugs eliciting simple responses, challenges arise for drugs triggering compensatory homeostatic mechanisms or developing tolerance (Castaneda et al., 1994). Moreover, the influence of formulation on pharmacokinetic and pharmacodynamic factors extends to the field of antipsychotics. New formulations offer sustained levels of medications, including long-acting antipsychotics and extended-release oral formulations. The intricate interplay between the rate of input, pharmacokinetics, and pharmacodynamics is highlighted, emphasizing that even bioequivalent formulations may not be equivalent in terms of therapeutic outcomes (Marazitti et al., 2013). As the focus on patient satisfaction, compliance, and overall treatment outcomes persists, the exploration of alternative routes of administration, such as inhalation, sublingual, and transdermal delivery, remains an avenue for refining medication therapy for individuals with psychiatric illnesses, specifically those requiring antipsychotic treatment (Kaminsky et al., 2015).

CARDIOVASCULAR SYSTEM DRUGS

Stereochemistry plays a crucial role in influencing the pharmacology of cardiovascular (CV) drugs, particularly those used in the treatment of hypertension and cardiac arrhythmias. Many of these drugs are chiral, meaning they exist as mirror-image isomers, or enantiomers. In the realm of hypertension treatment, examples include beta-antagonists, calcium channel blockers, and diuretics. The pharmacokinetic and pharmacodynamic properties of these drugs exhibit stereoselectivity, and understanding these nuances is essential for effective clinical use. For instance, beta-blockers, belonging to Class II antiarrhythmics, and chiral calcium channel blockers like verapamil, gallopamil, and prenylamine (Class IV antiarrhythmics) are employed in treating cardiac arrhythmias. The stereoselective nature of these drugs becomes evident in their varied pharmacological actions (Mehvar et al., 2004). Beta-blockers, when analyzed in terms of stereochemistry, show that the (–)-enantiomers exhibit higher activity in the arylaminoethanol and aryloxyaminopropanol groups compared to their (+)-enantiomers. This difference extends beyond activity and includes variations in other types of bioactivity and toxicity (Cizmarikova et al,. 2019). The challenges in understanding the fate of each isomer have been addressed by the development of High-Performance Liquid Chromatography (HPLC) methodology with chiral stationary phases (CSPs). This analytical approach allows for the separation and quantification of individual enantiomers in racemate administrations. Notably, the pharmacokinetic stages of these chiral drugs, including resorption, distribution, and metabolism, are intricately linked to their stereochemistry (Lalonde et al., 1988). Moreover, the chapter emphasizes the importance of accurate assessment of drug interactions and pharmacodynamic data. Findings indicate that using racemic (non-separated enantiomer) concentration data, rather than individual enantiomer data, can lead to misinterpretation in drug interaction studies. This is particularly relevant in the case of drugs like warfarin, where the potency difference between enantiomers has clinical significance (Chan et al., 2004). The formulation of cardiovascular (CV) drugs significantly impacts their pharmacology, especially when administered orally. While oral administration is convenient and enhances patient compliance, challenges such as poor aqueous solubility and enzymatic/metabolic stability can

limit the success of drug delivery. Nanotechnology-based drug delivery systems have emerged as a promising approach to overcome these challenges. Nanocarriers play a crucial role in improving the solubility profile, dissolution, and ultimately the bioavailability of hydrophobic antihypertensive drugs (Sharma et al., 2016). Taking felodipine as an example, its extendedrelease (ER) formulation, designed for once-daily administration, has demonstrated effectiveness in treating essential hypertension. The convenience of a single daily dose improves patient adherence and provides comparable efficacy to other antihypertensive agents. The formulation not only controls blood pressure effectively but also contributes to the regression of left ventricular hypertrophy, making it a versatile option for patients with various comorbidities such as diabetes, renal dysfunction, or asthma. Felodipine ER exemplifies how formulation innovations contribute to the overall success of antihypertensive therapy (Todd et al., 1992). In another example involving digoxin, the formulation played a critical role in addressing the adverse effects of high-dose cancer chemotherapy on drug absorption. Changing the dosage form from a tablet to a solution-in-capsule form helped overcome the reduction in bioavailability associated with cancer treatment-induced damage to the intestinal epithelium. This finding suggests that altering the oral dosage formulation can be a viable strategy to mitigate absorption issues caused by external factors like chemotherapy (Bjornsson et al., 1986). Furthermore, advancements in antiplatelet therapy, such as the development of extended-release acetylsalicylic acid (ASA), offer sustained antiplatelet effects over a 24-hour period with once-daily dosing. This innovation is particularly relevant for patients at high risk for recurrent cardiovascular events, providing continuous protection against thrombotic events (Bliden et al., 2015). Lastly, understanding the critical quality attributes (CQAs) of drugs like warfarin sodium is essential for maintaining their therapeutic efficacy. Manufacturing and formulation variables, such as the choice of excipients and granulation methods, influence drug properties like hardness, disintegration time, and dissolution rate. Changes in drug physical forms due to phase transformations and consolidation of particles during stability studies underscore the impact of formulation on the CQAs of warfarin sodium (Rahman et al., 2015).

ANTI CANCER DRUGS

In the past few years it has become clear that the individual stereoisomers, especially the enantiomers, of a biologically active chiral molecule may differ in potency,pharmacological action, metabolism, toxicity, plasma disposition and urine excretion kinetics.Understanding the distinct properties of enantiomers in chiral anticancer agents is essential for advancing personalized cancer treatments. Enantiomers are mirror-image stereoisomers of a molecule, and their unique characteristics can significantly influence drug efficacy and safety. Racemic mixtures, which contain equal amounts of both enantiomers, might lead to varied pharmacological responses and potential toxicity. Therefore, recognizing the specific attributes of individual stereoisomers becomes crucial for optimizing the therapeutic potential of chiral anticancer compounds in clinical oncology(Wainer IW,1993).Chiral molecules play a pivotal role in cancer chemotherapy, with enantiomers of compounds such as leucovorin, ifosfamide, buthionine sulfoximine, and verapamil exhibiting differences in pharmacological effects. Analytical methods developed for their stereoselective separation unveil distinct pharmacokinetic profiles. This distinction opens avenues for improved clinical effectiveness through the targeted administration of specific

isomers(Wainer IW, Granvil CP,1993).Moreover, the role of stereochemistry extends to the field of metal complexes in cancer treatment. Iron(III) complexes of N,N'-bis(salicylidene)-1,2-diaminocyclohexane were examined for anticancer activity against breast and colon carcinoma cells. The presence of iron significantly influenced antiproliferative effects, while the ligand configuration did not play a decisive role. These iron derivatives demonstrated potent anticancer activity within a concentration range of 1 to 5 microM, surpassing the effectiveness of cis-platin. The findings suggest a distinct mode of action not primarily targeting DNA, highlighting the importance of understanding the stereochemical aspects of metal complexes in cancer therapy(Hille A, Gust R,2009). the pursuit of more targeted and controlled approaches, a novel intratumoral chemoradiation strategy has been developed. It involves using poly(ethylene glycol)-poly(lactic acid) (PEG-PLA) block copolymers to encapsulate anticancer drug paclitaxel (PTX) and radioluminescent CaWO4 nanoparticles (NPs) in a radiation-controlled drug release formulation. Stereochemical analysis of paclitaxel enantiomers (PTX-S and PTX-B) revealed significant water solubility differences impacting X-ray-triggered release kinetics. In vivo studies demonstrated that the more water-soluble PTX-S exhibited superior short-term tumor suppression. This underlines the critical role of drug stereochemistry in controlled release therapies, offering a promising avenue for enhancing anticancer strategies(Sarkar K et al,2022).Expanding the scope, a synthesis of 27 chiral thiourea derivatives as potential anticancer agents further underscores the significance of stereochemistry. Compounds 7d, 7e1, and 7e3 exhibited heightened efficacy against colon, melanoma, ovarian, and breast cancers compared to the standard 5-fluorouracil. The study delves into the influence of stereochemistry in amino acid residues on tumor growth inhibitory activity, providing valuable insights for designing more effective and targeted anticancer agents(Kumar V et al,2014).Additionally, the acid-catalyzed isomerization of 4-hydroperoxyisophosphamide yielded a crystalline epimer with reversed stereochemistry at the phosphorus atom. Both epimers demonstrated similar metabolic behaviors, differing from isophosphamide. Interestingly, the newly isolated epimer displayed slightly higher activity against certain experimental tumors. This suggests that the inverted stereochemistry enhances the antitumor effectiveness of the activated species, emphasizing the intricate relationship between stereochemistry and the therapeutic potential of anticancer agents(Takamizawa A et al,1976).In conclusion, the collective findings underline the critical role of stereochemistry in the development and optimization of anticancer agents. From chiral molecules in traditional chemotherapy to metal complexes, controlled drug release formulations, and novel thiourea derivatives, the stereochemical aspects significantly impact pharmacological outcomes. Understanding and harnessing the unique properties of enantiomers offer opportunities for tailoring treatments, optimizing efficacy, and minimizing adverse effects. As research continues to unravel the complexities of stereochemistry in anticancer agents, it opens new avenues for designing more potent, selective, and personalized therapies to combat cancer effectively.

ANTIBIOTICS

Over the last two decades there has been a dramatic increase in the prevalence of bacterial pathogen that are increasingly difficult to treat with antibiotics (ABs), which has lead the World Health Organisation (WHO), US Centre for Disease Control (CDC) and European Centre for Disease Control (ECDC) to recognise infections caused by multiple drug resistant (MDR) bacteria

as a major public health problem.Enantiomeric synthesis of polymyxin B and its nonapeptide revealed diminished antibacterial activity, reduced LPS binding, and lower outer membrane permeabilization. The findings provide crucial insights into the stereochemical requirements governing the mechanisms of action, emphasizing the potential of polymyxins against antibiotic-resistant Gram-negative bacteria(Slingerland CJ et al.,2022).New napyradiomycins, A2 and B4, isolated from Chainia rubra MG802-AF1, were characterized. Napyradiomycin A2's structure was elucidated as 16-hydroxy-17-methylenenapyradiomycin A1 by NMR. The absolute structure of napyradiomycin B4 was determined as 13-hydroxy-13-methylnapyradiomycin B1 via X-ray crystallography, establishing the R configuration at C(4a). Napyradiomycin C1 exhibited 12E and 16E geometrical isomerism(Shiomi K et al.,1987).Antibiotic resistance (ABR) poses a global threat, demanding a 'one health' approach with environmental risk assessment. Overlooked but crucial, non-clinical settings contribute to ABR emergence. This exploration, using chloramphenicol as an example, emphasizes the impact of stereochemistry, specifically enantiomerism, on antibiotic properties, resistance mechanisms, and overall antimicrobial effectiveness(Elder FCT et al.,2020).Spectral methods (UV-VIS, IR, NMR, MS, and CD) revealed identical constitution and stereochemistry for quinone antibiotics sarubicin A and U-58,431. Chiroptical data, analyzed theoretically, established a common absolute configuration as 5S, 6R, 8R, 10R, highlighting their structural similarity through comprehensive spectroscopic characterization(Eckardt K et al.,1983).This paper presents Novo29, a novel antibiotic related to teixobactin, effective against Gram-positive bacteria. Synthesized through solid-phase peptide methods, Novo29's stereochemistry, determined as (2R,3R)-hydroxyasparagine, influences its amphiphilic conformation. Crystallography of epi-Novo29 reveals a structure resembling teixobactin, suggesting potential similar interactions with bacteria through hydrophobic and hydrophilic surfaces(Krumberger M et al.,2023).Lysinomicin, a novel aminocyclitol antibiotic, was characterized as 3-epi-2'-N-(L-beta-lysyl)-4',5'-didehydro-6'-de-C-methylfortimicin B through spectral evidence and chemical degradation. The degradation produced three additional compounds with interesting biological properties: 3-epi-2'-N-(L-beta-lysyl)-6'-de-C-methylfortimicin B, 3-epi-4',5'-didehydro-6'-de-C-methylfortimicin B, and 3-epi-6'-de-C-methylfortimicin B(Kurath P et al.,1984).Wastewater treatment plants, identified as potential antibiotic resistance hotspots, might also aid in bioremediation by metabolizing antibiotics. This study, focusing on stereochemistry, employed analytical tools to demonstrate stereoselective metabolism of chloramphenicol. The findings suggest environmental accumulation of isomers, raising concerns about ecotoxicity and bacterial antibiotic resistance emergence(Elder FCT et al.,2022).Daptomycin, a crucial antibiotic, engages with bacterial membrane lipid phosphatidylglycerol (PG) in a calcium-dependent manner. Its enantiomer, ent-dap, synthesized, demonstrated an 85-fold reduction in activity against B. subtilis, indicating dap's interaction with a chiral target. Liposome studies highlighted dap's preference for 2R,2'S PG configuration, impacting binding, structural transitions, and oligomerization, marking a unique connection between antibiotic activity and lipid head group configuration(Moreira R et al.,2022).Analysis of 1H NMR spectra for seven clinically significant tetracycline antibiotics in DMSO-d6 and other solvents provides insights into their solute stereochemistry and analytical utility. This study

enhances our understanding of these antibiotics at a molecular level, contributing valuable information for potential clinical applications(Moreira R et al.,2022).Chromic acid oxidation of manumycin, a Streptomyces parvulus antibiotic, produced key compounds revealing its stereochemistry. Absolute configuration at the diene side chain center was determined as (6'R). By comparing CD spectra, manumycin's stereochemistry at C-5, C-6, and C-4 was identified as (5R, 6S) and (4R) respectively, enhancing understanding of its molecular structure(Thiericke R et al.,1987).

ANTIVIRAL DRUGS

The examine delves into the problematic realm of antiretroviral drug production charges, with a specific focus on the expenses related to lively pharmaceutical ingredients (API). It underscores a noteworthy fashion wherein most drug charges align with decrease quartiles in developing nations, except for patented or limited-use drugs. The statistics on manufacturing charges not only serve as treasured negotiation benchmarks but additionally play a important function in sustaining HIV/AIDS remedy in aid-restrained areas.An important element highlighted within the have a look at is the ability for future charge reductions, which hinge on adjustments in API costs and further prices from providers. Collaborative efforts are explored, emphasizing techniques which includes adjusting API synthesis and using less expensive uncooked substances. The overarching goal is to optimize antiretroviral drug expenses, in the long run emphasizing the price for cash in settings where sources are constrained(Crawford KW et al.,2012).Shifting the point of interest to antiviral pills (AvDs), the narrative seamlessly transitions into their vital role in combatting viruses, considerably exemplified within the fight against COVID-19. However, the take a look at underlines that the effectiveness of AvDs may be constrained via negative bioavailability and the emergence of drug resistance. The key to enhancing their efficacy lies in a profound expertise of AvDs' metabolism and pharmacokinetics.This assessment meticulously examines the metabolic reactions of AvDs, their cell pharmacology, and the effect on each pharmacodynamics and pharmacokinetics. The exploration extends to the ability of shipping structures, in particular nanotechnology, to improve AvDs' effectiveness. Notably, tablets like ribavirin and remdesivir are highlighted for their promise towards SARS-CoV-2. The stronger comprehension of AvDs' metabolism is envisioned to pave the way for improved formulations, crucial in the treatment of virus-associated sicknesses, including the continuing conflict against COVID-19(Chen R et al.,2021).Shifting gears, the have a look at introduces a captivating size related to isomeric analogs of ddNs, with D and L absolute stereochemistries. These synthesized compounds are carefully assessed in vitro for their antiviral pastime. The findings display that some compounds show off strong consequences, spanning both D and L families. This modern approach in antiviral nucleoside research opens new frontiers, imparting get entry to to novel modified nucleosides. Despite emerging structure-activity relationships, the chiral isomeric nucleosides represent a promising avenue inside the quest for robust antiviral answers(Nair V et al.,1995).The narrative takes an aquatic flip, exploring the capability of carrageenan and its oligosaccharides sourced from crimson seaweed. These compounds showcase potent antiviral properties via blocking viral attachment. Beyond their antiviral efficacy, they provide numerous biological blessings and function the muse for controlled drug delivery systems. The overview scrutinizes numerous types of carrageenans, which includes λ-, ι-, and κ-carrageenans, each encouraged via diploma and sulfation function. The sustainable sourcing of those compounds

globally is emphasized, along with the impact of producing strategies on composition, shape, and antiviral efficacy(Álvarez-Viñas M et al.,2021).A familiar call in antiviral therapeutics surfaces—Acyclovir, a nucleoside analogue concentrated on herpesviruses. The take a look at elucidates its effectiveness in exceptional bureaucracy, emphasizing topical utility for ocular herpetic keratitis and preliminary genital herpes. The versatility of oral and intravenous forms is mentioned, aiding in each initial and recurrent genital herpes. The nuanced advantages and barriers of acyclovir in numerous medical situations, inclusive of its position in immunocompromised patients, are meticulously explored(Richards DM et al.,1983).The narrative then embarks on a ancient journey, tracing extensive development in antiviral drug development since the discovery of HIV in 1983. The emergence of HCV in 1989 spurred analogous efforts, hinting on the potential for combination regimens corresponding to HIV treatments. The article meticulously explores drug targets throughout the existence cycles of each viruses, delving into the records, chemistry, and mechanisms of movement of accredited and investigational capsules. Parallels are drawn from anti-HIV drug design, presenting insights into future treatment techniques towards HCV(De Clercq E 2007).The have a look at takes a futuristic flip, emphasizing the significance of potent antiviral drugs. Functional nanoparticles, including quantum dots, gold, and silver nanoparticles, come to be powerful retailers with staggering antiviral abilties. A complete overview overlaying 132 papers underscores the efficacy, mechanisms, and evaluation methods of these nanoparticles. The dialogue extends to their unique functions, advancements, benefits, and disadvantages, shedding light on their viricidal packages. The exploration concludes with the aid of addressing demanding situations and potentialities in the realm of antiviral nanostructures(Chen L et al.,2020).The significance of stereochemistry in drug design is elucidated, emphasizing its function in how drug enantiomers engage biologically. The importance of chirality will become obvious, as enantiomers can show off versions in pharmacology. The take a look at advocates for the switch from racemates to unmarried isomers, highlighting the improved protection and efficacy supplied by using single enantiomer capsules. However, it cautions that prescribers must rely upon clinical evidence for assessing cost-effectiveness and stepped forward consequences. The FDA's function in permitting patented unmarried enantiomers of regularly occurring capsules underneath extraordinary names is mentioned, at the side of policies mandating remoted, pure enantiomers for efficacy and protection trying out. Despite the advantages, the look at acknowledges that unexpected toxicities in chiral switching instances have brought about marketplace withdrawals or halted development.The exploration of Acyclovir's pharmacokinetics gives a nuanced understanding of its removal, distribution, and dosing traits. Renal elimination of unchanged drug commonly defines its pharmacokinetics, with distribution extending to cerebrospinal fluid and tissues, observed by means of minimal plasma protein binding. The dose-unbiased kinetics facilitate predictable plasma levels, especially thru non-stop infusion. The interplay among renal characteristic, half-existence, and clearance necessitates dosage changes, particularly in adults in which age-related clearance declines correlate with modifications in renal feature(de Miranda P et al.,1983).In conclusion, this comprehensive assessment encapsulates the multifaceted landscape of antiviral drug research and improvement. It navigates via production costs, the intricacies of drug metabolism, modern strategies in nucleoside research, the capability of herbal compounds, the

flexibility of hooked up pills like Acyclovir, and the evolving landscape of antiviral nanostructures. The historic journey and future potentialities offer a holistic knowledge of the demanding situations and possibilities in combating infectious illnesses, leaving the reader with a nuanced angle at the ever-evolving discipline of antiviral therapeutics.

SUMMARY

The influence of stereochemistry on pharmacological properties spans various drug classes, as highlighted in this comprehensive review. Beginning with antipsychotic drugs, the significance of chiral centers in shaping efficacy and safety is evident. Enantiomeric disparities, exemplified by citalopram, underscore the importance of selecting the more potent stereoisomer for enhanced therapeutic outcomes. Moreover, advancements in drug formulations, such as extended-release options, cater to patient needs and improve treatment compliance. Moving to cardiovascular drugs, stereoselectivity plays a crucial role in drugs like beta-blockers and calcium channel blockers, impacting their pharmacodynamic actions. Innovative formulations, including those designed for once-daily administration, offer convenience and efficacy, particularly in managing hypertension and cardiac arrhythmias. In the realm of antibiotics, understanding stereochemistry is vital for optimizing drug properties and combating antibiotic resistance. Studies reveal how enantiomeric synthesis affects antibacterial activity, providing insights into mechanism of action and resistance. Additionally, nanotechnology-based drug delivery systems show promise in improving the solubility and bioavailability of hydrophobic antibiotics, contributing to more effective treatment strategies. In the context of anticancer drugs, stereochemistry influences potency, metabolism, and toxicity, offering opportunities for personalized cancer treatments. Novel formulations and controlled release strategies aim to enhance therapeutic efficacy while minimizing adverse effects. Furthermore, insights into metal complexes' stereochemical aspects unveil potent anticancer activity, opening avenues for targeted therapies. Finally, in antiviral drug development, understanding stereochemistry is pivotal for optimizing drug metabolism and formulation. Nanotechnology presents innovative approaches to improve drug effectiveness, particularly in combating viral infections like COVID-19. Additionally, exploring isomeric analogs and natural compounds underscores potential avenues for developing robust antiviral solutions. In conclusion, the review emphasizes the indispensable role of stereochemistry in drug development across diverse therapeutic areas. By elucidating the complex interplay between drug stereochemistry, formulation, and pharmacological properties, this research paves the way for more effective and tailored pharmacotherapy.

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