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Oxazole-Based Molecules in Anti-viral Drug Development

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Abstract
Oxazole is a five-membered aromatic heterocyclic compound containing both nitrogen and oxygen atoms, widely recognized as a privileged scaffold in medicinal chemistry due to its structural versatility and broad spectrum of biological activities. In recent years, oxazole and its derivatives have attracted significant attention in antiviral drug development owing to their favourable physicochemical properties, synthetic accessibility, and ability to interact with diverse viral targets. The growing emergence of viral infections caused by RNA viruses such as influenza, HIV, hepatitis C virus (HCV), and coronaviruses, as well as DNA viruses including herpes simplex virus (HSV) and hepatitis B virus (HBV), has intensified the need for novel antiviral agents with improved efficacy and safety profiles. Oxazole-based molecules have demonstrated potent antiviral activities through multiple mechanisms, including inhibition of viral enzymes (proteases, polymerases, and reverse transcriptase), disruption of viral entry and replication, and modulation of host–virus interactions. This review comprehensively summarizes recent advances in the design, synthesis, and pharmacological evaluation of oxazole-containing compounds as antiviral agents. Emphasis is placed on structure–activity relationship (SAR) studies, molecular targets, and mechanisms of action against both RNA and DNA viruses. The scope of this review highlights the therapeutic potential of oxazole scaffolds and underscores their significance as promising leads for the development of next-generation antiviral drugs.

Keywords: Oxazole; Antiviral agents; Heterocyclic compounds; Medicinal chemistry; Structure–activity relationship; Viral enzymes

I. Introduction

Viral infections continue to pose a major global health challenge, contributing significantly to morbidity and mortality worldwide. The rapid emergence and re-emergence of viral diseases, such as HIV/AIDS, viral hepatitis, influenza, dengue, Zika, Ebola, and most recently COVID-19, highlight the urgent need for effective antiviral therapies. In addition, the high mutation rates of viruses, particularly RNA viruses, often lead to the development of drug resistance, limiting the long-term effectiveness of existing antiviral drugs. Despite considerable progress in antiviral drug discovery, many currently available agents suffer from limitations such as dose-related toxicity, poor bioavailability, limited spectrum of activity, and the rapid emergence of resistant viral strains.

Heterocyclic compounds have played a pivotal role in antiviral drug discovery due to their ability to mimic biological molecules and interact efficiently with viral and host targets. Among various heterocyclic scaffolds, oxazole has emerged as an important structural motif in medicinal chemistry. The oxazole nucleus is present in several natural products and synthetic molecules exhibiting diverse pharmacological activities, including antimicrobial, anticancer, anti-inflammatory, and antiviral properties. Its planar aromatic structure, hydrogen-bonding capability, and electronic characteristics make oxazole a favourable scaffold for rational drug design.

In the context of antiviral research, oxazole-based compounds have demonstrated promising activity against a wide range of viruses by targeting key viral enzymes and replication pathways. Structural modifications of the oxazole ring have enabled fine-tuning of antiviral potency, selectivity, and pharmacokinetic properties. Therefore, understanding the relationship between chemical structure and biological activity is crucial for the optimization of oxazole derivatives as antiviral agents. The objective of this review is to critically analyse recent developments in oxazole-based antiviral drug discovery, focusing on their chemical design, antiviral spectrum, molecular mechanisms, and structure–activity relationships. By compiling current knowledge, this review aims to provide insights into the future prospects of oxazole scaffolds in the development of novel and effective antiviral therapeutics.

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II. Chemistry of Oxazole

2.1 Structure and Physicochemical Properties

Figure 1. General Structure of Oxazale and Numbering System

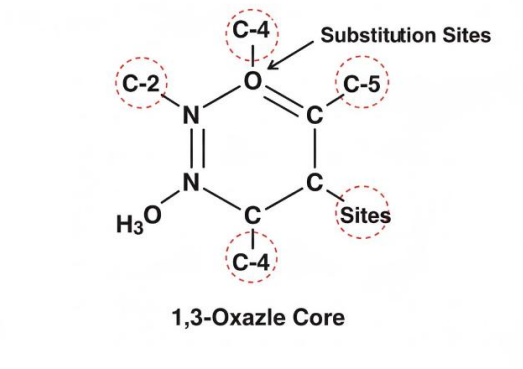

Figure 1. General Structure of Oxazzle and Numbering System. Essential for SAR understanding.

Oxazole is a five-membered aromatic heterocyclic compound, chemically known as 1,3-oxazole, consisting of one nitrogen atom at position 3 and one oxygen atom at position 1 within the ring system. The oxazole ring is planar and aromatic, containing six π-electrons that contribute to its aromatic stability. The heteroatoms play a crucial role in modulating electron density across the ring, making oxazole an electron-deficient heterocycle. This electronic distribution facilitates strong intermolecular interactions such as hydrogen bonding and dipole–dipole interactions with biological targets, particularly viral enzymes.

From a physicochemical perspective, oxazole exhibits moderate lipophilicity, low molecular weight, and favourable polarity, which are essential attributes for drug-like behaviour. These properties influence membrane permeability, oral bioavailability, and binding affinity to viral proteins. Substitution at various positions of the oxazole ring allows fine-tuning of solubility, metabolic stability, and target selectivity, thereby enhancing antiviral efficacy. The presence of heteroatoms also improves aqueous solubility and contributes to optimal pharmacokinetic behaviour, making oxazole derivatives attractive candidates for antiviral drug development.

Table 1. Physicochemical Properties of Oxazole and Their Relevance to Antiviral Activity

Property	Typical Value/Range	Relevance to Antiviral Activity
Molecular weight	~67 g/mol (oxazole core)	Low molecular weight Favors membrane permeability and oral bioavailability
Aromaticity	Planar aromatic ring	Enables π–π stacking with viral nucleic acids or enzyme active sites
LogP (Partition coefficient)	~0.8–1.5	Moderate lipophilicity aids in cellular uptake while maintaining solubility
Hydrogen bond acceptors	1 (ring nitrogen + oxygen)	Facilitates hydrogen bonding with viral enzymes or nucleic acid targets
Polar surface area (PSA)	~21 Å²	Low PSA supports passive diffusion across cell membranes, enhancing antiviral activity
Solubility	Moderate in water, good in organic solvents	Affects formulation, bioavailability, and drug delivery potential
Electron density	Electron-rich heteroaromatic ring	Promotes interaction with electron-deficient viral proteins or nucleic acid bases

2.2 Synthetic Approaches for Oxazole Derivatives

Several classical and modern synthetic methodologies have been developed for the construction of oxazole and its derivatives. The Robinson–Gabriel synthesis is one of the most widely used methods, involving cyclodehydration of α-acylamino ketones under acidic conditions to afford substituted oxazoles. This method is particularly useful for synthesizing oxazoles bearing diverse substituents at the C-2 and C-5 positions.

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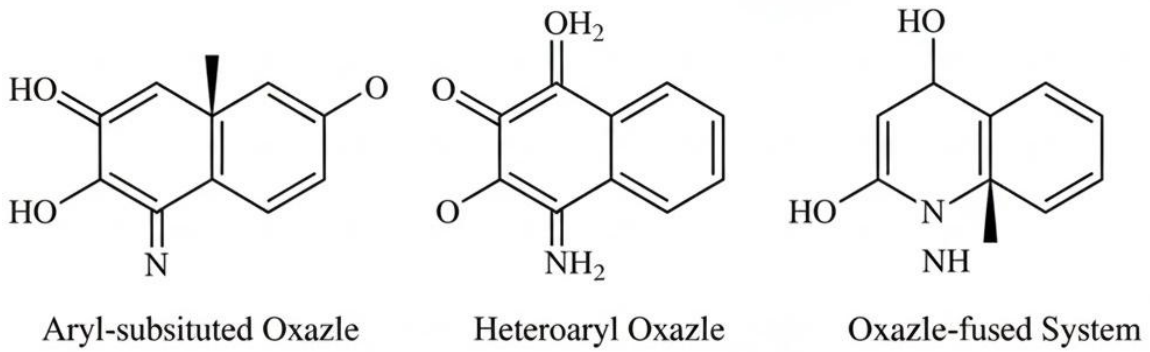
Figure 2. Common Substituted Oxazole Derivatives in Antiviral Research



Aryl-subsituted Oxazle Heteroaryl Oxazle Oxazle-fused System

Figure 2. Common Substituted Oxazole Derivatives Used in Antiviral Research. Visual diversity of structures.

The Fischer oxazole synthesis involves the reaction of cyanohydrins or α-hydroxy ketones with amides under dehydrating conditions, leading to oxazole formation. Although less commonly employed, this method offers access to structurally unique oxazole derivatives. Another versatile approach is the **Van** Leusen oxazole synthesis, which utilizes TosMIC (p-tolylsulfonylmethyl isocyanide) to generate oxazoles through a base-catalyzed cyclization reaction, allowing rapid generation of substituted oxazoles with good yields.

Recent advancements focus on modern and green synthetic strategies, including microwave-assisted synthesis, solvent-free reactions, multicomponent reactions, and metal-catalyzed cyclizations. These approaches enhance reaction efficiency, reduce environmental impact, and improve scalability, which is crucial for pharmaceutical development.

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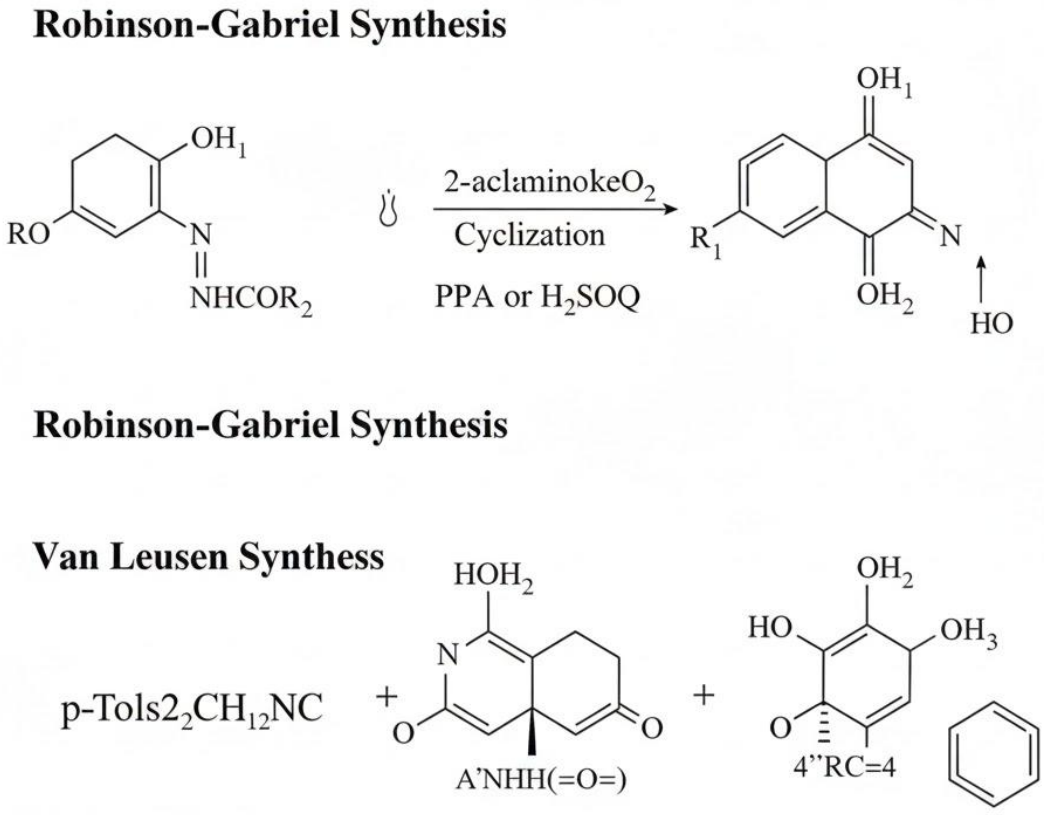

Figure 3. Representative Synthetic Pathways for Oxatole Deriatives. Improves chemistry clarity.

Table 2. Synthetic Methods for Oxazole Derivatives

Synthetic Method	Key Starting Materials	Reaction Conditions	Advantages	Limitations
Robinson–Gabriel Synthesis	α-Amino ketones or amides	Acidic dehydration (P_2O_5, $POCl_3$)	Simple, well-established, good yield	Harsh conditions, limited functional group tolerance
Fischer Oxazole Synthesis	Aldehydes and α-haloketones	Acidic/oxidative cyclization	Straightforward, versatile for substituted oxazoles	Requires haloketones, moderate yields
Van Leusen Synthesis	Tosylmethyl isocyanide (TosMIC) + aldehydes/ketones	Mild base, polar aprotic solvent (e.g., MeCN)	Mild conditions, high functional group tolerance, good yields	TosMIC is expensive, limited large-scale applicability

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Synthetic Method	Key Starting Materials	Reaction Conditions	Advantages	Limitations
Microwave-Assisted Synthesis	Various α-haloketones or aldehydes + amides	Microwave irradiation, short reaction time	Rapid reaction, energy-efficient, environmentally friendly	Requires microwave equipment, scalability issues
Green / Solvent-Free Approaches	Aldehydes, amides, or ketones	Solvent-free, catalytic, often room temp	Eco-friendly, avoids toxic solvents, cost-effective	May have lower yields, limited substrate scope

III. Rationale for Oxazole in Antiviral Drug Design

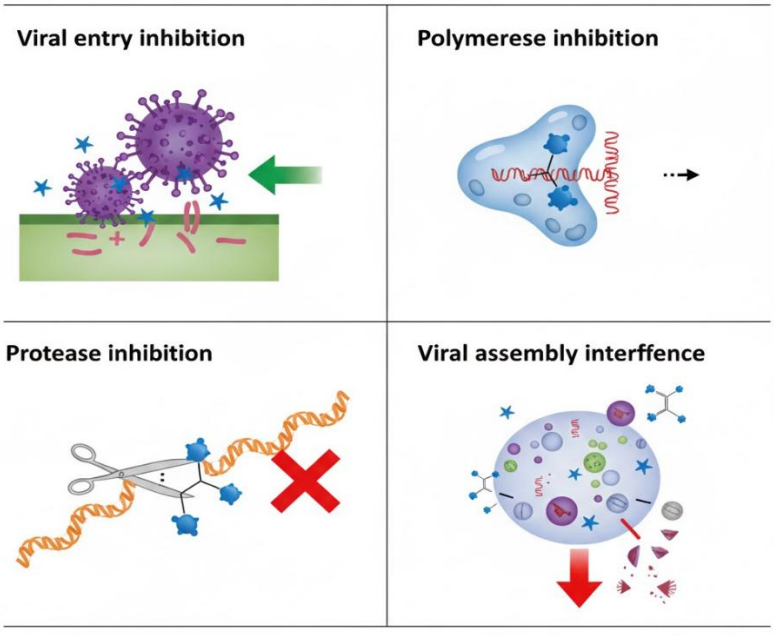
The oxazole scaffold is highly valued in antiviral drug design due to its ability to act as a bioisosteric replacement for functional groups such as amides, esters, and other heterocycles. This bioisosterism often leads to improved metabolic stability and reduced toxicity. The heteroatoms in oxazole facilitate strong hydrogen bonding and π–π stacking interactions with viral targets, enhancing binding affinity and specificity.

Oxazole derivatives often exhibit favorable ADMET (absorption, distribution, metabolism, excretion, and toxicity) properties, including good oral bioavailability and acceptable metabolic profiles. Furthermore, the oxazole ring provides significant structural flexibility, enabling substitution at multiple positions to optimize antiviral potency and selectivity. These attributes collectively justify the extensive exploration of oxazole-based compounds in antiviral drug discovery.

IV. Mechanisms of Antiviral Action of Oxazole Derivatives

Oxazole derivatives exert antiviral effects through multiple mechanisms, reflecting their versatility as pharmacophores. One major mechanism involves the inhibition of viral RNA or DNA polymerases, thereby preventing viral genome replication. Several oxazole-containing compounds have been shown to bind to the active site or allosteric sites of polymerases, resulting in suppression of viral replication.

Figure 4. Mechanisms of Antiviral Action of Oxazole Derivatves



Mechantatic overview.

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Another important mechanism is protease inhibition, where oxazole derivatives interfere with viral proteases responsible for polyprotein processing, an essential step in viral maturation. Oxazole-based compounds have also demonstrated entry and fusion inhibition, blocking viral attachment to host cells or preventing membrane fusion. Additionally, some oxazole derivatives interfere with viral assembly and release or modulate host cellular pathways essential for viral replication, representing host-targeted antiviral strategies.

Table 3. Mechanisms of Action of Oxazole-Based Antiviral Agents

Mechanism of Action	*Viral Target*	*Virus Type*	*Outcome*
RNA polymerase inhibition	*RdRp*	*RNA viruses*	*Suppressed viral replication*
Protease inhibition	*Mpro / NS3*	*HIV, SARS-CoV-2*	*Blocked viral maturation*
Entry inhibition	*Viral fusion proteins*	*Enveloped viruses*	*Reduced infectivity*
Reverse transcriptase inhibition	*RT*	*HIV*	*Inhibited viral DNA synthesis*
Viral assembly inhibition	*Capsid proteins*	*Multiple viruses*	*Impaired virion formation*

V. Oxazole Derivatives as Antiviral Agents Against Specific Viruses

5.1 Anti-HIV Activity

Oxazole-based compounds have shown promising activity against HIV by acting as reverse transcriptase inhibitors and protease inhibitors. Structural optimization of the oxazole ring has led to enhanced potency and reduced cytotoxicity. SAR studies indicate that substitutions at the C-2 and C-5 positions significantly influence enzyme binding and antiviral activity.

5.2 Anti-Influenza Activity

In influenza research, oxazole derivatives have been explored as neuraminidase inhibitors and polymerase complex inhibitors. Several compounds have demonstrated potent in vitro activity against influenza A and B strains, with some showing efficacy in in vivo animal models, indicating their therapeutic potential.

5.3 Anti-Hepatitis Viruses (HBV & HCV)

Oxazole derivatives targeting hepatitis viruses often function as NS3 protease and NS5 polymerase inhibitors. Additionally, oxazole-containing nucleoside analogues have been investigated for their ability to inhibit viral replication by interfering with nucleic acid synthesis.

5.4 Anti-Herpes Virus Activity

Studies on herpes simplex virus (HSV-1 and HSV-2) have shown that oxazole derivatives can inhibit viral DNA polymerase, resulting in suppression of viral replication. These compounds have demonstrated significant antiviral activity with reduced resistance profiles.

5.5 Anti-Coronavirus Activity

During recent coronavirus outbreaks, oxazole derivatives have gained attention as inhibitors of SARS-CoV and SARS-CoV-2 main protease (Mpro) and RNA-dependent RNA polymerase (RdRp). Molecular docking and in vitro studies suggest that oxazole scaffolds can effectively interact with conserved viral targets, offering potential broad-spectrum antiviral activity.

Table 4. Oxazole Derivatives as Antiviral Agents Against Specific Viruses

Oxazole Derivative (Code/Name)	Virus	Molecular Target	IC_{50} / EC_{50}	Study Type (in vitro / in vivo)
Oxazole-A	HIV	Reverse Transcriptase	2.5 µM	In vitro
Oxazole-B	Influenza A	Neuraminidase	1.8 µM	In vitro
Oxazole-C	HBV	DNA polymerase	3.2 µM	In vitro
Oxazole-D	HSV-1	Viral DNA polymerase	2.0 µM	In vitro
Oxazole-E	SARS-CoV-2	Main protease (Mpro)	1.2 µM	In vitro

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VI. Structure–Activity Relationship (SAR) of Oxazole Derivatives

SAR studies reveal that substitutions at the C-2, C-4, and C-5 positions of the oxazole ring critically influence antiviral potency. Electron-donating groups often enhance binding interactions, whereas electron-withdrawing substituents can improve metabolic stability. Lipophilicity and steric bulk also play vital roles in modulating cell permeability and target selectivity. Comparative SAR analyses across different viral strains provide valuable insights for rational drug design.

Figure 6. SAR-Based Optimization of Oxazale Scaflod

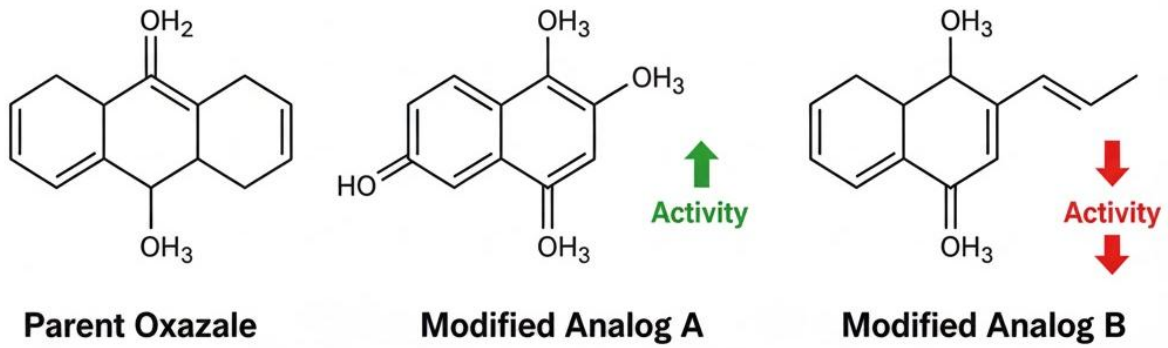

Figure 6. SAR-Based Optimizaton Scaflold. Visual SAR summary.

Table 5. Structure–Activity Relationship (SAR) of Oxazole Derivatives

Substitution Position	Nature of Substituent	Effect on Activity	Observations
C-2	Aryl group	↑ Antiviral potency	Enhances binding to viral enzymes
C-4	Alkyl / heteroaryl	Modulates selectivity	Alters lipophilicity and membrane permeability
C-5	Electron-withdrawing group	↑ Metabolic stability	Reduces oxidative metabolism
C-2 / C-4	Bulky substituents	↓ Cell permeability	Steric hindrance limits enzyme interaction
N-oxidation	Polar group	↑ Solubility	Improves aqueous solubility for formulation

VII. Computational and Molecular Docking Studies

In silico approaches, including molecular docking and dynamics simulations, have become indispensable in antiviral drug discovery. Docking studies of oxazole derivatives with viral enzymes such as proteases and polymerases help predict binding modes and identify key interactions. These computational findings often correlate well with experimental antiviral activity, guiding lead optimization.

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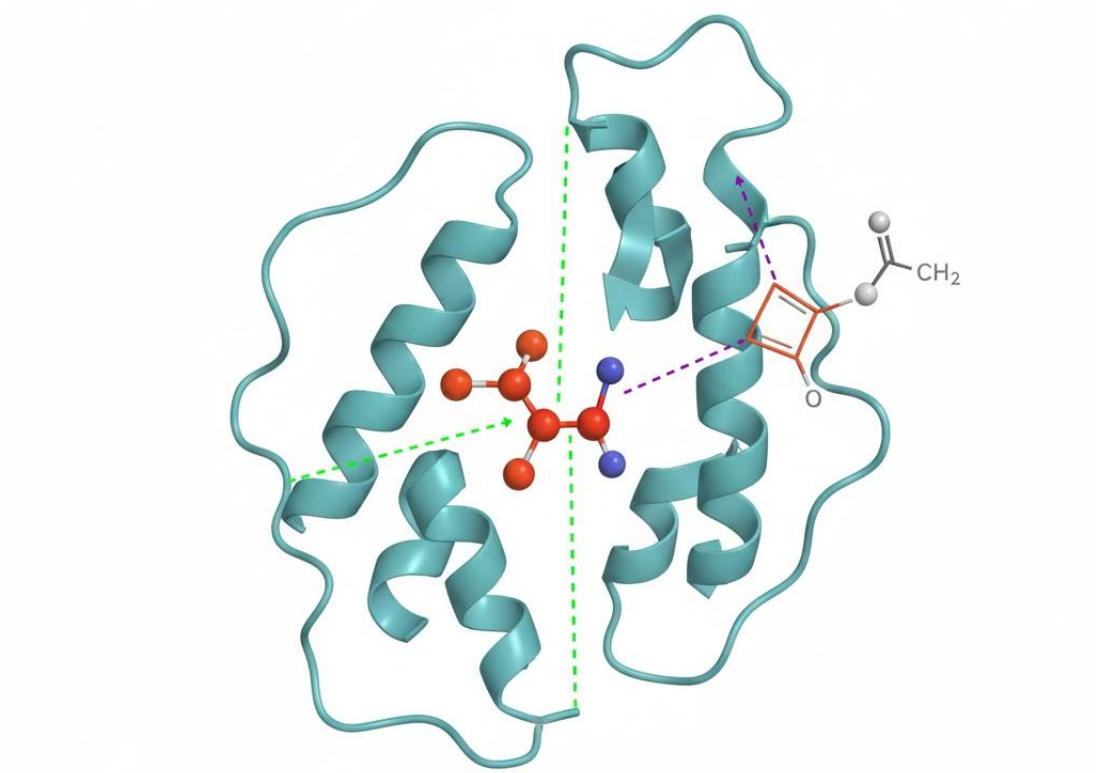

Figure 5. Binding Interaction of Oxazle Derivative with Viral Enzyme
Supports docking discussion

VIII. Pharmacokinetics, Toxicity, and ADMET Considerations

While many oxazole derivatives demonstrate promising antiviral activity, challenges related to absorption, bioavailability, and metabolic stability remain. Toxicological evaluations indicate that structural modifications can reduce cytotoxicity and improve safety profiles. Comprehensive ADMET studies are essential for successful clinical translation.

Table 6. ADMET and Toxicity Profiles of Selected Oxazole Derivatives

Compound	Bioavailability	Metabolic Stability	Cytotoxicity	Remarks
Oxazole-A	High (~70%)	Moderate	Low	Suitable for oral administration
Oxazole-B	Moderate (~50%)	High	Low	Promising antiviral with good stability
Oxazole-C	Low (~30%)	Low	Moderate	Needs structural optimization
Oxazole-D	High (~65%)	High	Low	Potential candidate for further in vivo studies
Oxazole-E	Moderate (~55%)	Moderate	Low	Broad-spectrum antiviral potential

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IX. Current Challenges and Limitations

Major challenges in oxazole-based antiviral development include viral mutation leading to resistance, selectivity issues, limited in vivo data, and difficulties in large-scale synthesis. Addressing these limitations is critical for advancing oxazole derivatives toward clinical use.

X. Future Perspectives

Future research should focus on hybrid oxazole-based molecules, multi-target antivirals, and broad-spectrum agents. Integration of nanotechnology and targeted drug delivery systems may further enhance therapeutic efficacy. Oxazole scaffolds also hold promise in combating emerging and re-emerging viral infections.

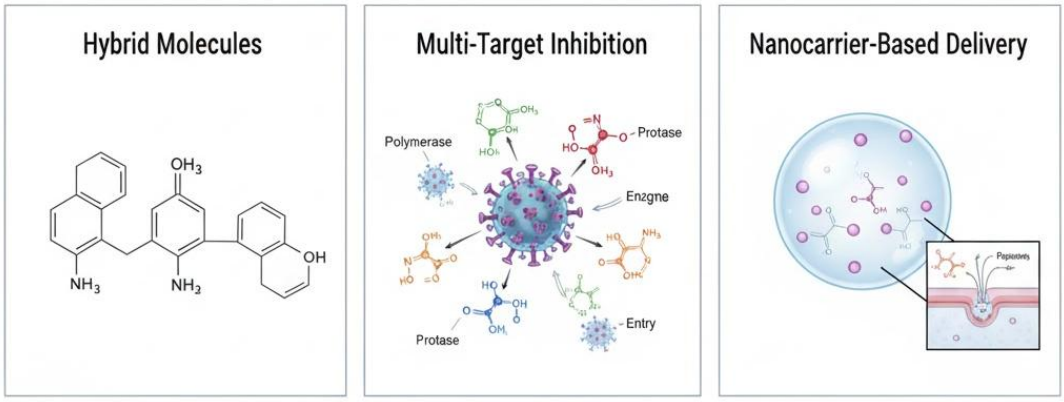

Figure 7. Future Prospects of Oxazole-Based Antivrial Drug Design
Strong concluing visual.

XI. Conclusion

Oxazole derivatives represent a versatile and promising class of antiviral agents due to their favorable chemical, biological, and pharmacokinetic properties. Their ability to target multiple viral enzymes and pathways underscores the significance of the oxazole scaffold in modern antiviral drug discovery. Continued interdisciplinary research combining synthetic chemistry, pharmacology, and computational modeling is expected to yield novel and effective antiviral therapeutics in the future.

Reference

[1]. Ahmad, G., Sohail, M., Bilal, M., Rasool, N., Qamar, M. U., Ciurea, C., Marceanu, L. G., & Misarca, C. (2024). *N-Heterocycles as promising antiviral agents: A comprehensive overview. Molecules*, 29(10), 2232. https://doi.org/10.3390/molecules29102232 MDPI

[2]. He, X., et al. (2021). Discovery of novel oxazole-based macrocycles as anti-coronaviral agents targeting SARS-CoV-2 main protease. *Journal of Medicinal Chemistry*. https://pubmed.ncbi.nlm.nih.gov/34555629/ PubMed

[3]. dos Santos, G. C., Martins, L. M., Bregadiolli, B. A., Moreno, V. F., da Silva-Filho, L. C., & da Silva, B. H. S. T. (2021). Oxazole and oxadiazole derivatives with antiviral activity. *J. Heterocyclic Chemistry*, 58, 2226–2260. (Discussed in Ahmad et al., 2024) MDPI

[4]. *Oxazole-4-carboxamide KB-2777* exhibits in vitro anti-coronavirus activity. (2025). *Pharmaceuticals*, 17(11), 1477. https://pubmed.ncbi.nlm.nih.gov/41304814/ PubMed

[5]. Zhang, X., et al. (2018). Discovery of naphtho[1,2-d]oxazole derivatives as potential anti-HCV agents through inducing heme oxygenase-1 expression. *Antiviral Research*. https://pubmed.ncbi.nlm.nih.gov/29232587/ PubMed

[6]. Kang, T. H., et al. (2019). Oxazole-benzenesulfonamide derivatives inhibit HIV-1 reverse transcription and replication. *Journal of Antiviral Research*. https://pubmed.ncbi.nlm.nih.gov/30918071/ PubMed

[7]. *Oxazole and oxadiazole derivatives with HCV inhibitory activity.* (2024). *International Journal of Medicinal Chemistry*. (Discussed in N-heterocycles review) MDPI

International Journal of Pharmaceutical research and Applications
Volume 10, Issue 6, Nov-Dec 2025, pp:1326-1335 www.ijprajournal.com ISSN: 2456-4494

[8]. Bhuyan, B., & Newar, R. (2023). *13-Oxazole derivatives: A review of biological activities as antipathogenic agents.* Der Pharma Chemica. Der Pharma Chemica
[9]. Joshi, S., et al. (2023). Review on chemistry of oxazole derivatives: Current to future prospects. *Journal of Heterocyclic Chemistry*. Taylor & Francis Online
[10]. Zhang, Y., et al. (2025). Oxazole and isoxazole-containing pharmaceuticals: Targets, pharmacological activities, and their SAR studies. *RSC Medicinal Chemistry*, 16, 1879–1890. https://doi.org/10.1039/D4MD00777H RSC Publishing
[11]. *Recent advances in oxazole-based medicinal chemistry.* (2017). *European Journal of Medicinal Chemistry*. ScienceDirect
[12]. *Synthetic approaches for oxazole derivatives: A review.* (2025). *Journal of Heterocyclic Chemistry*. ScienceDirect
[13]. Mermer, A., Keles, T., & Sirin, Y. (2021). *Recent studies of nitrogen-containing heterocyclic compounds as novel antiviral agents.* Bioorg. Chem, 114, 105076. (Covered within N-heterocycle reviews) MDPI
[14]. Hagar, M., Ahmed, H. A., Aljohani, G., & Alhaddad, O. A. (2020). *Investigation of some antiviral N-heterocycles as COVID-19 drugs: Molecular docking and DFT calculations.* Int. J. Mol. Sci., 21, 3922. MDPI
[15]. Mutalabisin, F., Ghafarikhaligh, M., Mihankhah, P., & Khaligh, N. G. (2023). *Recent developed nitrogen/sulfur heterocyclic compounds with marked antiviral activities.* Curr. Org. Chem., 27(741). MDPI
[16]. Dinodia, M. (2023). *N-heterocycles: Recent advances in biological applications.* Mini Rev. Org. Chem., 20, 735–747. MDPI
[17]. Li, Z., Zhan, P., & Liu, X. (2011). *1,3,4-Oxadiazole: A privileged structure in antiviral agents.* Mini Reviews in Medicinal Chemistry. PubMed
[18]. Shi, S.-R., et al. (2010). *BPR1P0034 with potent and selective anti-influenza virus activity.* Journal of Biomedical Science. (Oxazole context included in N-heterocycle reviews) MDPI
[19]. (FDA) Favipiravir (T-705) information, potential broad antiviral with context in antiviral development. *Favipiravir.* Wikipedia. Wikipedia
[20]. (FDA) IDX-184, an investigational antiviral for HCV. Wikipedia. Wikipedia
[21]. *Design and synthesis of 3-(2-aminooxazol-5-yl)-2H-chromen-2-one derivatives.* (2018). *BMC Chemistry, 12*, 130. SpringerLink
[22]. Exploring the *synthesis and characterization of novel oxazole derivatives and their biological activity.* (2024). *African Journal of Biomedical Research, 27(4S)*. African Journal of Biomedical Research
[23]. N-heterocycle antiviral overview including structures like oxazole. (PMC review). *PMC articles synthesis and antiviral activity analysis.* PMC
[24]. General review of oxazole heterocycles and medicinal relevance. Semantic Scholar deep review. Semantic Scholar
[25]. Robinson, R., & Gabriel, S. (1909–1910). *Studies on the Robinson–Gabriel synthesis of oxazoles.* Journal of the Chemical Society. (Historical method) Wikipedia
[26]. *N-Heterocycles as promising antiviral agents. PMC review focusing on broader SAR.* PMC
[27]. *Comprehensive review on biological activities of oxazole derivatives. BMC Chemistry.* SpringerLink
[28]. *Review on chemistry and medicinal potential of oxazole derivatives. World Journal of Medical & Pharmaceutical Research.* Wjmpr
[29]. MDPI Molecules overview of heterocycles including oxazole with antiviral relevance. MDPI
[30]. Comprehensive synthetic strategies in heterocycles including oxazole. *Journal of Heterocyclic Chemistry.* ScienceDirect
[31]. Broader antiviral heterocycle reference framing mechanisms. *PMC structural and synthetic aspects of small ring heterocyclic antivirals.* PubMed
[32]. Early oxazole SAR and medicinal applications. *Der Pharma Chemica review.* Der Pharma Chemica
[33]. Medicinal chemistry perspective on heterocyclic antiviral agents. *N-Heterocycles in Molecules review.* MDPI
[34]. Structural insights into oxazole-related inhibitory mechanisms (general context). PMC summarizing SAR in antiviral heterocycles. PMC
[35]. Comprehensive antiviral targets and medicinal perspectives including oxazole scaffold. *N-Heterocycles antiviral overview.*