

Chapter 2

Bioactive Pyrazoles: Structure, Function, and Pharmaceutical Potential

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ABSTRACT

This chapter discusses about bioactive pyrazoles, which have garnered substantial attention in medicinal chemistry and drug development. Pyrazoles are five-membered heterocyclic compounds characterized by a nitrogen-rich structure, imparting them with unique physicochemical and biological and making them useful for treating various diseases. The chapter explores the synthesis, structural diversity, and functional modifications of pyrazoles that enhance their bioactivity. Detailed discussions highlight the mechanisms of action and therapeutic potential of pyrazole derivatives in various pharmacological areas, including anti-inflammatory, anticancer, antimicrobial, antiviral, neuroprotective, and other applications. The chapter also looks at the latest research and advancements in pyrazole chemistry, including new ways to make them and studies on how their structure affects their activity. By exploring the many uses of bioactive pyrazoles, this chapter shows their importance in contemporary medicinal chemistry in developing new and better medicines.

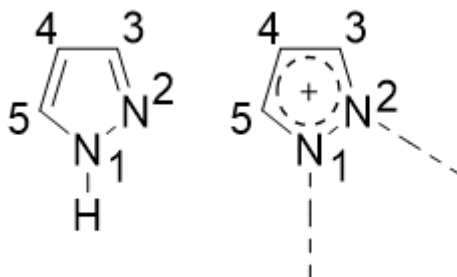
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1. INTRODUCTION

Heterocyclic compound chemistry is a complex subfield of organic chemistry, encompassing more than half of all known organic compounds. Heterocycles are a diverse and significant class of molecules with a wide range of reactivity, stability, and applications across chemical, biological, and physical domains (Eftekhari-Sis et al., 2013). This diversity makes them intriguing for their synthetic techniques, theoretical implications, and extensive physiological and industrial uses. Heterocycles are abundant in nature, found in natural products like antibiotics, vitamins, and alkaloids, as well as in agrochemicals, medicines, and dyes. They play a crucial role in metabolism and are the fundamental structures of many biologically active molecules, especially nitrogen-containing heterocycles (Ansari et al., 2017; Ju & Varma, 2005).

Pyrazoles, a key class of heteroaromatic ring systems, are widely used in the drug industry. Their fundamental structure consists of a five-membered ring with two neighboring nitrogen atoms and three carbon atoms, giving them an aromatic system (Nisa & Astana, 2019). Due to its electronegativity, the nitrogen atom attracts ring electrons, making the C(3) and C(5) atoms electropositive and prone to nucleophilic reactions. In 1,2-azoles, the pyridine nitrogen and C(4) atoms influence π -electron distribution, altering the charge on C(3) and C(5) depending on the heterocycle (Behr et al., 1967).

Figure 1. Structure of Pyrazole



Pyrazole, capable of forming intermolecular hydrogen bonds, has boiling, and melting points of 187–188 °C and 70 °C, respectively. With a tendency towards basic character rather than acidic character, Pyrazole exhibits amphoterism. And hence, in addition to forming sodium and potassium salts, it easily hydrolyzes salts in strong acids (Marinescu & Zalaru, 2021). Pyrazoles, also referred to as azoles, are ligands for several lewis acids (Mukherjee, 2000). Due to the rapid interconversion,

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