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Heterocyclic Compounds and Their Applications

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ABSTRACT

Due to their many important biological and medicinal applications, heterocyclic compounds have attracted a lot of research. The vast synthetic investigation and functional value of heterocyclic compounds have led to a significant increase in research interest in these molecules. They bridge the gap between biology and chemistry, the fields that yield so much scientific discovery and application and are present in over 90% of new medications. Additionally, heterocycles are useful in a variety of domains, such as biology and pharmaceutical chemistry. Heterocyclic compounds are mostly used in veterinary products, agrochemicals and pharmaceuticals. Heterocyclic compounds have many uses in pharma companies for example these are used in anti-fungal , anti inflammatory, anti bacterialanti viral, anti oxidant, anti convulsant, anti helmintic, anti histamine, herbicidal, anti cancer, anti hypertensive and anti leprosyetc activities. This paper has tried to evaluate the classification of Heterocyclic compounds especially based on structural illustration of in the emerging pharmaceutical world.

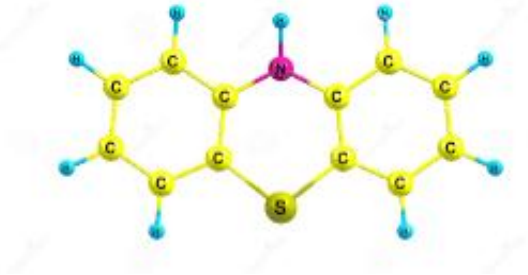
Keywords: Heterocyclic compounds, biology, chemistry, pharmaceutical chemistry.

INTRODUCTION

In organic chemistry, the most well known and diverse class of molecules having uses in biology and synthesis are known as heterocyclic compounds. The term “cyclic” in heterocyclic refers to the presence of a compound with a single ring structure, and it comes from the ‘greek’ word Kylos, which means circle or ring. On the other hand, thenon carbon atoms or heteroatoms in the ring are indicated by heteroatoms in the ring are indicated by prefix hetero, which is derived from the greek word heteros and means” other”. These are the rings or compounds when a cyclic compound has at least two distinct components present in one of its rings. This is the primary source for organic chemistry, which investigates the properties, production and applications of heterocycles. The most basic examples of five membered heterocyclic compounds are thiophene, furan and pyrrole; these compounds have single heteroatoms in each bit and atoms of nitrogen, oxygen and Sulphur.

These chemicals fall into two categories: aromatic heterocyclic compounds and aliphatic heterocyclic compounds on the basis of electronic configuration. As an illustration, aliphatic heterocyclic compounds includes amines, ethers, alcohols and so on, where as aromatic heterocyclic compounds include pyridine, indols, quinine and so forth. Due to their benefits in synthesis and endless study, heterocyclic compounds of which there are currently about sixty are growing quickly. Because they are interested in treating various disorders, they are used in the biological field and play a significant part in science. They serve as building blocks for the synthesis of organic compounds and are employed in the agricultural and pharmaceutical sectors.

According to the literature survey study, many heterocyclic compounds have practical use in the diseases like triazine derivative, and it has been used as anti-microbial (ofloxacin), herbicides, urinary antiseptics, and anti-inflammatory agents (diclofenac). Benzimidazole derivatives describe multiple uses in biological activities such as anti-bacterial (gentamycin) and anti-helminthic (nematodes) etc. They are continuously found in biologically active compounds, enzymes, vitamins, and natural products. Some heterocyclic compounds are elementary to life, like haem derivatives in blood, and chlorophylls are essential for plants. Heterocyclic compounds have various uses in many drugs that have been studied in the past, like antibacterial agents, anti-allergic agents, anti-HIV and anti-cancer activity (cis-platin, carbo- platin).



Structure of heterocyclic compound

The past study of heterocyclic compounds:
The growth of organic chemistry in the 1800s marked the beginning of the history of heterocyclic compounds. Below, are some of the interesting results:
IN 1818: Alloxanis separated from uric acid by brugnatelli.
IN 1832: Doberiener used sulphuric acid to process starch to produce furfural (a furan).
IN 1834: Runge used dry distillation to produce pyrrole from bones.
IN 1906: Friedlander synthesized indigo dye which allowed allowing synthetic chemistry to replace a large agricultural sector.
IN 1936: Treibs used crude oil to produce derivatives of Chlorophyll.
IN 1951: Chargaff gave a genetic code rule and the importance of heterocyclic compounds ("purines and pyrimidines bases").

CLASSIFICATION OF HETEROCYCLIC COMPOUNDS:

Heterocyclic compounds can be divided into two categories based on how their electrons are arranged
Regarding aliphatic and aromatic heterocyclic molecules, below are some interesting points**.**

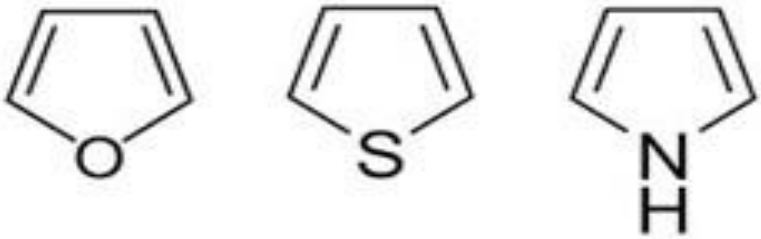
a. Compounds with aliphatic heterocycles

- Compounds that are aliphatic heterocyclic do not have a double bond.
- Ring strain has an impact on the characteristics of heterocyclic compounds.
- Huckel's Rule states that aliphatic heterocyclic compounds must be planar, cyclic and devoid of sp^3 hybridized atoms.
- Aziridine, Oxirane, Thiirane, etc., are some common examples of Aliphatic Heterocyclic compounds.

Aziridine Oxirane

b. Compounds with aromatic heterocycles

- Compounds that are aromatic heterocyclic are, as their name implies, cyclic aromatic compounds.
- It needs to contain (4n+2) π electrons.
- These compounds resemble benzene rings.
- Common examples of Aromatic Heterocyclic compounds include pyridine, furan, pyrrole etc.



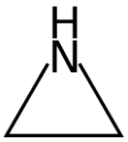
Furan **Thiophene** **Pyrrole**

CLASSIFICATION BASED ON STRUCTURAL ILLUSTRATION:

Heterocyclic compounds are classified into the following groups which are listed below: -

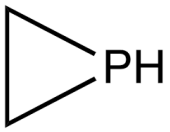
Compounds containing three heterocyclic members and one heteroatom

- Saturated heterocyclic compounds: aziridine, oxirane, phosphirane, etc.
- Unsaturated heterocyclic compounds: azirine, oxirene, etc.



Aziridine

Oxirane



Phosphirane

Azirine

Oxirene

Compounds containing four heterocyclic members and one heteroatom

Saturated heterocyclic compound oxetane, thietane, etc.

- Unsaturated heterocyclic compounds: oxete, thiete, etc.

Oxetane

Thietane

Oxete

Thiete

Compounds containing five heterocyclic members and one heteroatom:

- Saturated heterocyclic compounds: pyrollidine, tetrahydrofuran, etc.
- Unsaturated heterocyclic compounds: pyrrole, furan, etc.

Pyrrolidine

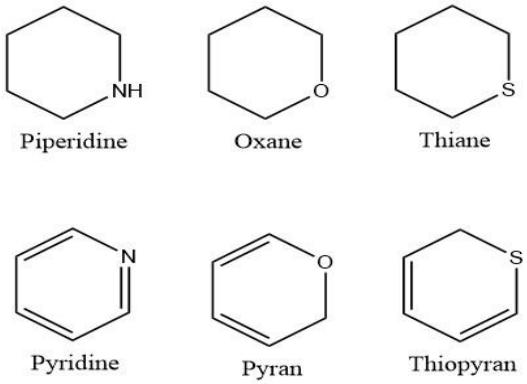
Tetrahydrofuran

Pyrrole

Furan

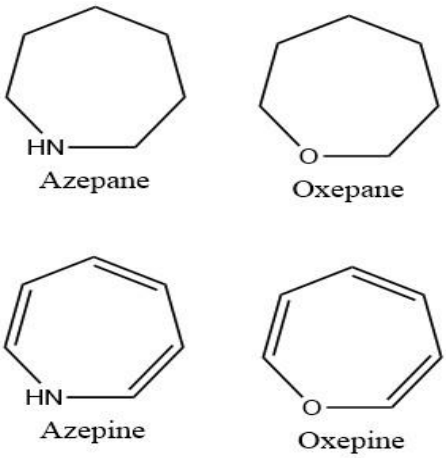
Compounds containing six heterocyclic members and one heteroatom

- Saturated heterocyclic compounds: piperidine, oxane, thiane, etc.
- Unsaturated heterocyclic compounds: pyridine, pyran, thiopyran, etc.



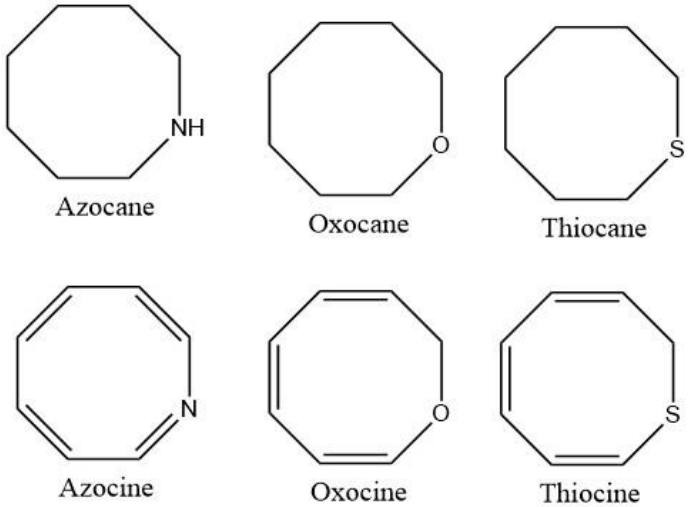
Compounds containing seven heterocyclic members and one heteroatom

- Saturated heterocyclic compound: azepane, oxepane, etc.
- Unsaturated Heterocyclic compounds: azepine, oxepine, etc.



Compounds containing eight heterocyclic members and one heteroatom

- Saturated heterocyclic compounds: azocane, oxocane, thiocane.
- Unsaturated Heterocyclic compounds: azocine, oxacine, thiocine.



Compounds containing nine heterocyclic members and one heteroatom

- Saturated Heterocyclic compounds: azonane, oxonane, thionane.
- Unsaturated Heterocyclic compounds: azonine, oxonine, thionine.
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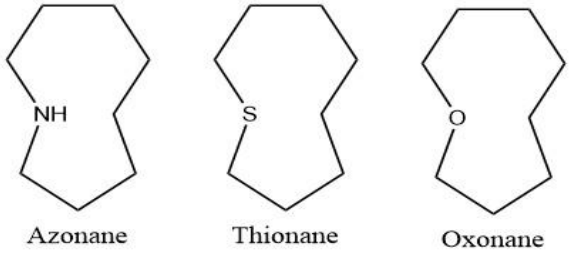
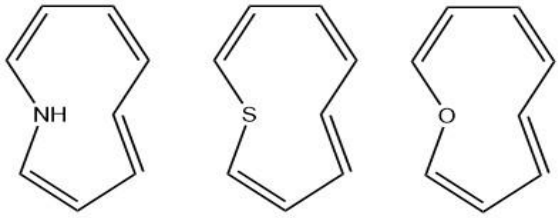


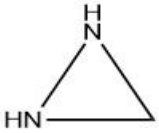
Azonane Thionane Oxonane



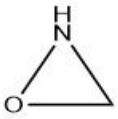
Azonine Thionine Oxonine

Compounds containing three heterocyclic members and two heteroatoms

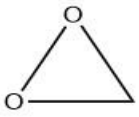
- Saturated heterocyclic compounds: diaziridine, oxaziridine, and dioxirane (highly unstable).
- Unsaturated heterocyclic compounds: diazirine.



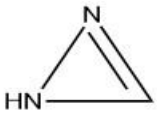
Diaziridine



Oxaziridine



Dioxirane

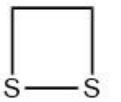


Diazirine

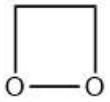
Compounds containing four heterocyclic members and two heteroatoms

- Saturated heterocyclic compounds: diazetine, dioxetane, and dithietane.
- Unsaturated heterocyclic compounds: diazete, dioxete, dithiete, etc.

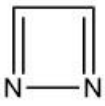
Diazetine



Dithietane



Dioxetane



Diazete

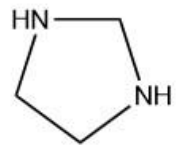
Dithiete

Dioxete

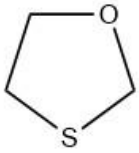
Compounds containing five heterocyclic members and two heteroatoms

- Saturated heterocyclic compounds: imidazolidine, oxathiolidine, thiazolidine, etc.

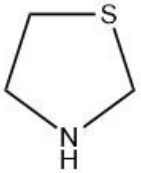
- Unsaturated heterocyclic compounds: imidazole, oxathiole, thiazole, etc.



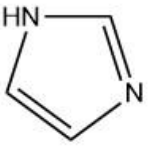
Imidazolidine



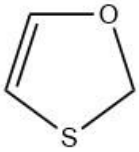
Oxathiolidine



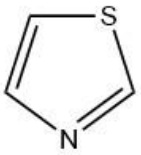
Thiazolidine



Imidazole



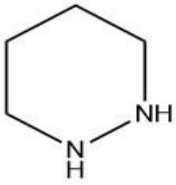
Oxathiole



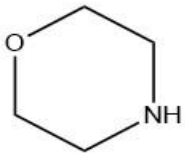
Thiazole

Compounds containing six-heterocyclic members and two heteroatoms

- Saturated heterocyclic compounds: diazinane, morpholine, dioxane, etc.
- Unsaturated heterocyclic compounds: diazine, oxazine, dioxine, etc.

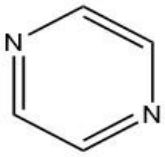


Diazinane

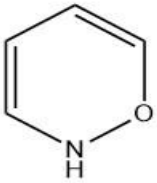


Morpholine

Dioxane



Diazine

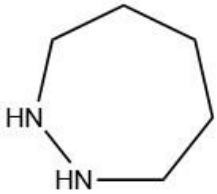


Oxazine

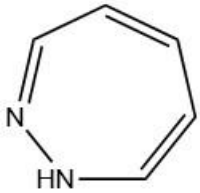
Dioxine

Compounds containing seven heterocyclic members and two heteroatoms

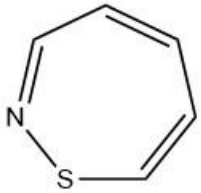
- Saturated heterocyclic compounds: diazepane.
- Unsaturated heterocyclic compounds: diazepine, thiazepine.



Diazepane



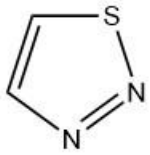
Diazepine



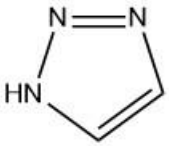
Thiazepine

Compounds containing five heterocyclic members and three heteroatoms

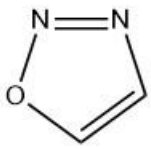
- Unsaturated heterocyclic compounds: thiadiazole, triazoles, oxadiazole, etc.



Thiadiazole



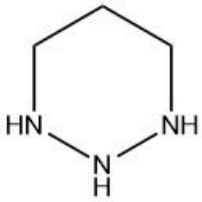
Triazoles



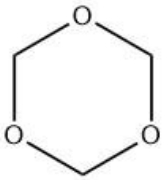
Oxadiazoles

Compounds containing six heterocyclic members and three heteroatoms

- Saturated heterocyclic compounds: triazinane, trioxane, trithiane, etc.
- Unsaturated heterocyclic compounds: triazine.

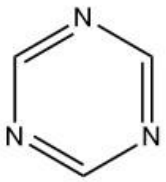


Triazinane



Trioxane

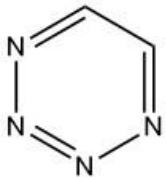
Trithiane



Triazine

Compounds containing six heterocyclic members and four heteroatoms

- Unsaturated heterocyclic compounds: tetrazine



Tetrazine

CONCLUSION

It has been observed that amongst the different heterocyclic compounds, five and six membered heterocyclic compounds are mainly used for the research work. These Heterocyclic compounds are mostly used in veterinary products, agrochemicals and pharmaceuticals. Heterocyclic compounds have many uses in pharma companies for example these are used in anti-fungal , anti inflammatory, anti bacterialanti viral, anti oxidant, anti convulsant, anti helmintic, anti histamine, herbicidal, anti cancer, anti hypertensive and anti leprosyetc activities.
In these decades, many incurable diseases are spreading worldwide of which have the medicines do not exist or are under process. The heterocyclic compounds can offer a possible solution in this way.

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