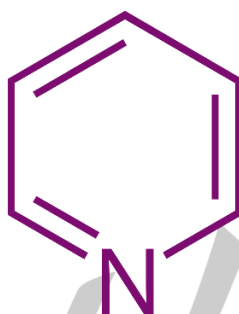


Heterocyclic compounds

Heterocyclic Compounds

- A **heterocyclic compound** is a cyclic compound that contains atoms of at least two different elements in its ring structure.
- Typically, these rings are made of **carbon atoms** and at least one **heteroatom**, such as:
 - Nitrogen (N)
 - Oxygen (O)
 - Sulfur (S)
- Heterocyclic compounds can be aromatic or non-aromatic, and they may contain single rings or multiple fused rings.



Applications of Heterocyclic Compounds

- **Pharmaceuticals:** Many drugs contain heterocyclic rings, including antibiotics (e.g., penicillin), antivirals, and anticancer agents.
- **Biological molecules:** Nucleic acids (DNA/RNA bases), vitamins (B1, B6), alkaloids.
- **Agrochemicals:** Herbicides, fungicides, and insecticides.
- **Materials science:** Organic semiconductors, dyes, and polymers.

Examples of Common Heterocyclic Compounds

Name	Structure Type	Notes
Pyridine	6-membered, 1 N	Analogous to benzene with 1 nitrogen
Pyrrole	5-membered, 1 N	Found in porphyrins and heme
Furan	5-membered, 1 O	Aromatic but more reactive than benzene
Thiophene	5-membered, 1 S	Aromatic, used in conductive materials
Imidazole	5-membered, 2 N	Found in histidine and enzymes
Indole	Benzene + pyrrole	Present in tryptophan, serotonin
Thiazole	5-membered, S and N	Found in vitamin B1 (thiamine)

Purine	Double-ring, 4 N	Base of DNA (adenine, guanine)
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Classification of Heterocyclic Compounds

Heterocyclic compounds are classified based on several criteria:

By Ring Size

1. Three-membered rings

- Saturated: Aziridine (N), Oxirane (epoxide with O)
- Unsaturated: Azirine, Oxirene

2. Four-membered rings

- Saturated: Azetidine, Oxetane
- Unsaturated: Azetine, Oxete

3. Five-membered rings

- Saturated: Pyrrolidine, Tetrahydrofuran
- Unsaturated (aromatic or partially unsaturated):
 - Pyrrole (with N)
 - Furan (with O)
 - Thiophene (with S)

4. Six-membered rings

- Saturated: Piperidine, Morpholine
- Unsaturated:
 - Pyridine (with N)
 - Pyran (with O)

5. Larger rings (macrocycles)

- More than six members, such as crown ethers, porphyrins, and cyclic peptides

	Saturated			Unsaturated		
3-atom ring	Aziridine	Oxirane	Thiirane	Azirine	Oxirene	Thiirene
						
	Azetidine	Oxetane	Thietane	Azete	Oxete	Thiete

4-atom ring						
5-atom ring	<i>Pyrrolidine</i>	<i>Oxolane</i>	<i>Thiolane</i>	<i>Pyrrole</i>	<i>Furan</i>	<i>Thiophene</i>
6-atom ring	<i>Piperidine</i>	<i>Oxane</i>	<i>Thiane</i>	<i>Pyridine</i>	<i>Pyran</i>	<i>Thiopyran</i>
7-atom ring	<i>Azepane</i>	<i>Oxepane</i>	<i>Thiepane</i>	<i>Azepine</i>	<i>Oxepine</i>	<i>Thiepine</i>
8-atom ring	<i>Azocane</i>	<i>Oxocane</i>	<i>Thiocane</i>	<i>Azocine</i>	<i>Oxocine</i>	<i>Thiocine</i>
9-atom ring	<i>Azonane</i>	<i>Oxonane</i>	<i>Thionane</i>	<i>Azonine</i>	<i>Oxonine</i>	<i>Thionine</i>

By Saturation

- **Saturated heterocycles:** Only single bonds (e.g., piperidine)
- **Unsaturated heterocycles:** Contain double or triple bonds
- **Aromatic heterocycles:** Conjugated systems that obey Huckel's Rule ($4n + 2 \pi$ electrons), providing aromatic stability

By Number of Heteroatoms



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