Lecture 5 2022-2033

Heterocyclic compounds

Heterocyclic compounds are cyclic compounds having five- or six-membered rings containing carbon and other element, and the other element may be nitrogen (N), oxygen (O), or sulfur (S). Figure 1. **Heterocyclic chemistry** is the branch of organic chemistry dealing with the synthesis, properties, and applications of these heterocycles.

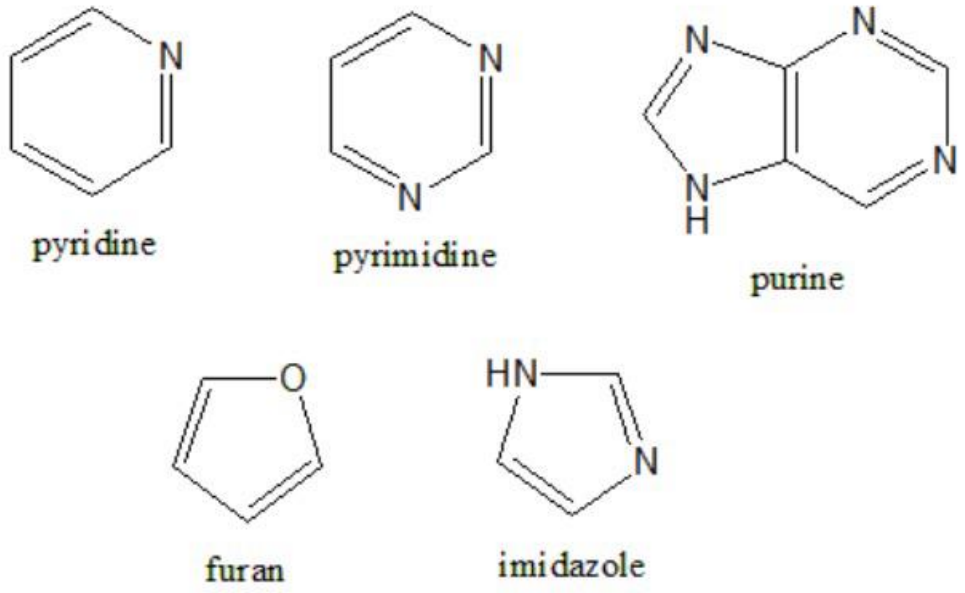


Figure 1: Heterocyclic compounds

Many heterocyclic compounds , including some amines are carcinogenic.

Classification of Heterocyclic Compounds:

Heterocyclic compounds classification **depend on ring size and** classified into:-

1-The five membered heterocyclic compounds.

Consist of five cyclic compounds having one heteroatom example Furan.

2-The Six membered heterocyclic compounds.

Consist of six cyclic membered heterocyclic ring having one heteroatom as in pyridine. Figure 1.

Distribution of Heterocycles in nature

Heterocyclic compounds occur widely in nature .A large number of heterocyclic compounds are essential for life .Various compounds contain heterocyclic ring such as Hemoglobin ,hormones, amino acids , essential amino acids(**that cannot be made**

by the body. As a result, they must come from food and their number are 9) , alkaloids(**are naturally occurring chemical compounds containing basic nitrogen atoms , which are produced by a large variety of organisms, including bacteria, fungi, plants and animals. Many alkaloids often have pharmacological effects and are used as medications**) , vitamins ,antibiotics and a large number of synthetic drugs and dyes contain heterocyclic ring system.

Knowledge of heterocyclic chemistry is useful in biosynthesis of drug , metabolism as well as nucleic acids (are naturally occurring chemical compounds that serve as the primary information-carrying molecules in cells. They play an especially important role in directing protein synthesis.

Nitrogen heterocyclic ring compounds

1-An azole is a class of five-membered nitrogen heterocyclic ring compounds containing at least one other non-carbon atom of either nitrogen , sulfur , or oxygen, which are used as antifungal drugs Figure 2.

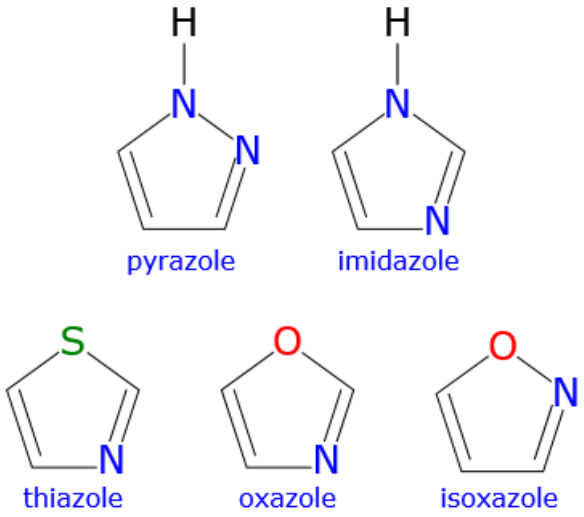


Figure 2: Azole compounds

2- Imidazole is aromatic heterocyclic compounds with two nitrogen atoms .Imidazole is extremely common in nature and forms the core of many biomolecules Figure 3

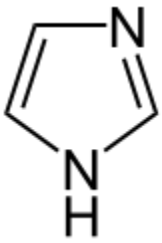


Figure 3:Imidazole

Introduction To Some Kinds of Heterocyclic Compounds

1. Heterocyclic Indole Ring Compounds

L-Tryptophan is an amino acid having an indole ring in its structure. Figure 4 Indoles are compounds containing a benzene ring attached to a five-membered nitrogen containing pyrrole ring. Tryptophan is an essential amino acid that serves several important purposes, like Nitrogen balance in adults. Growth in infants. It is essential to creates the neurotransmitter serotonin.

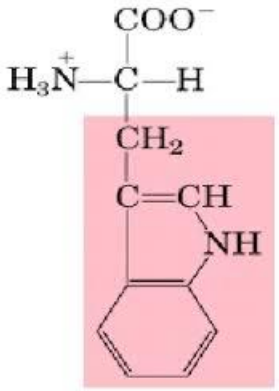


Figure 4: The structure of Indole ring in amino acid L-Tryptophan.

Most drugs on the market contain the indole substructure. These include INDOMETHACIN. It is a nonsteroidal anti-inflammatory drug (NSAID). It works by blocking the body's production of certain natural substances that cause inflammation. This effect helps to decrease swelling by Inhibit pain in joint diseases and treat gout and pain.

Non-steroidal anti-inflammatory drugs(NSAIDs) are medicines that are widely used to relieve pain, reduce inflammation, and bring down a high temperature. They're often used to relieve symptoms of headaches, colds and flu, arthritis, and other causes of long-term pain.

2. Heterocyclic DNA & RNA

There are two types of nucleic acids which are polymers found in all living cells. Deoxyribonucleic Acid (DNA) is found mainly in the nucleus of the cell, while Ribonucleic Acid (RNA) is found mainly in the cytoplasm of the cells. Heterocycles are the major components of biological molecules such as DNA & RNA, and DNA is without a doubt the most important macromolecule of life. Heterocyclic Amines (Cytosine C, Thiamine T, Uracil U, Adenine A, and Guanine G) are Heterocyclic amines of DNA, & RNA are sometimes called nitrogen bases or simply bases. **Figure 5**

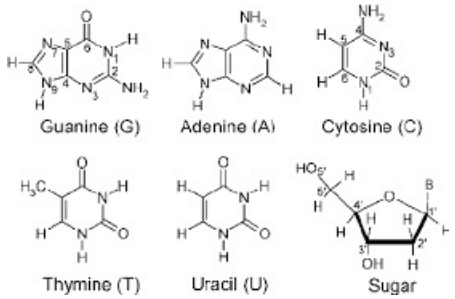
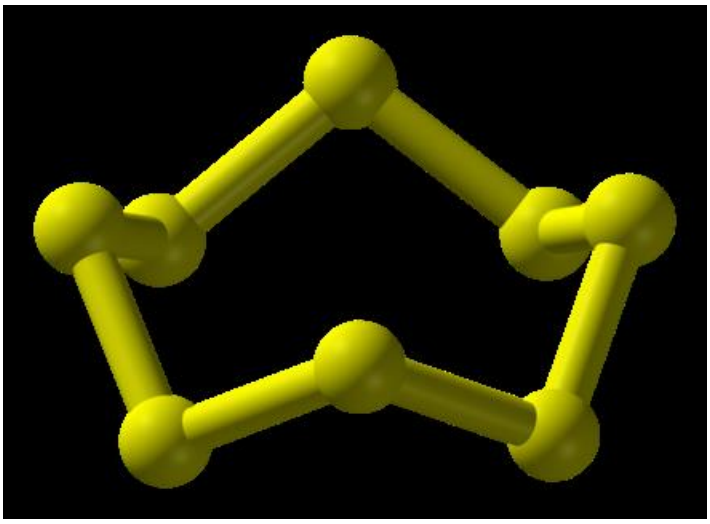


Figure 5: Heterocyclic amines and basis of DNA & RNA

Sulfur

Sulfur (or Sulphur in British English) is an octal chemical element and present in nature a core structure named sulfur (S8). Elemental sulfur is non-toxic. When sulfur burns in air, it produces sulfur dioxide. In water, this gas produces sulfurous acid and sulfites; sulfites are antioxidants that inhibit growth of aerobic bacteria and a useful food additive in small amounts

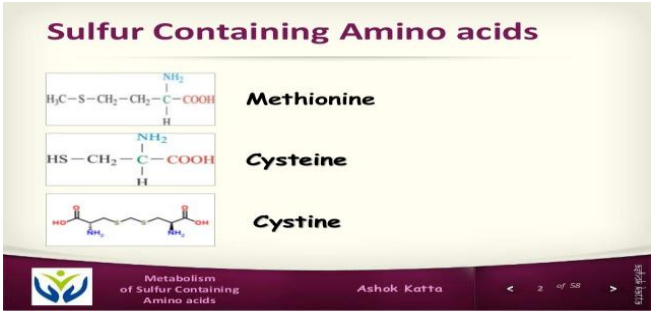


sulfur (S8).

Importance of sulfur in life

Sulfur essential element for all life , in the form of organosulphur compounds or metal sulfides.

1- Three amino acids (cysteine, cysteine and methionine) present in all poly peptides, enzymes and proteins.



2- Two vitamins (biotin(B7) and thiamine(B1) are organosulfur compounds.

3-Many cofactors (is a non-protein chemical compound or metallic ion that is required for an enzyme's role as a catalyst (a catalyst is a substance that increases the rate of a

chemical reaction). Cofactors can be considered "helper molecules" that assist in biochemical transformations) are also contain sulfur including glutathione.

Using of Sulfur as Pharmaceuticals:

1- Pharmaceutical skin treatment of acne.
2- Kills bacteria, fungi, scabies mites and other parasites.
3- Sulfur is used, in lotions, creams, powders, & soaps, so sulfur-containing antibiotics

Sulfonamides are antimicrobials drugs used in the treatment of bacterial infections.