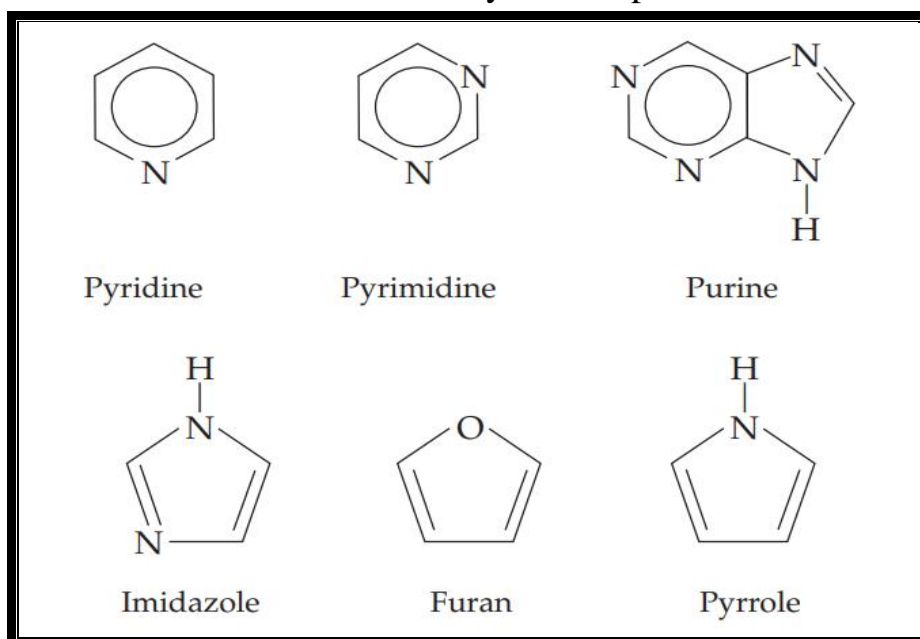


Lecture 4: Heterocyclic compounds & the chemistry of antibiotics

4.1 Heterocyclic compounds

Heterocyclic compounds are cyclic compounds having five- or six-membered rings containing carbon and another element, and the other element may be nitrogen (N), oxygen (O), or sulfur (S). The structures and common names of several heterocyclic compounds are shown below:

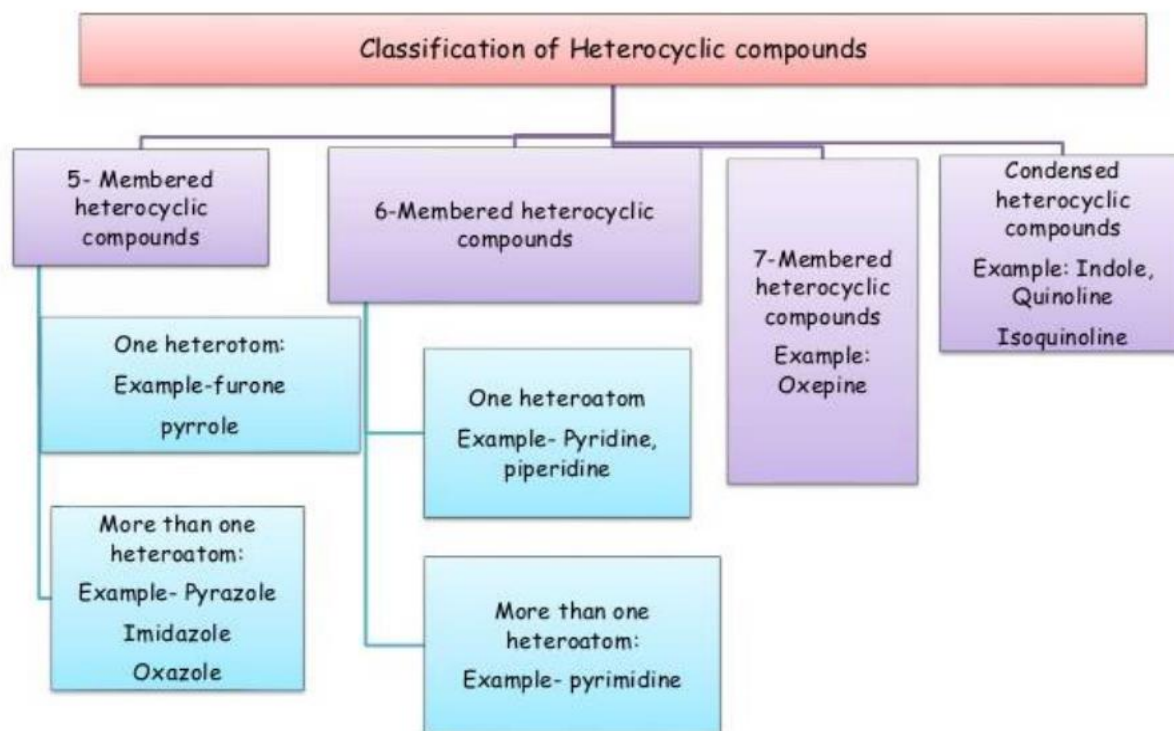


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- All these compounds are more similar to benzene in stability and chemical behavior than they are to the alkenes.
- Many of these compounds are components of molecules that have significant effects on biological systems. The pyrimidine and purine rings are found in DNA (deoxyribonucleic acid) and RNA (ribonucleic acid). DNA and RNA are the molecules responsible for storing and expressing the genetic information of an organism. The porphyrin ring structure is found in hemoglobin (an oxygen-carrying blood protein), myoglobin (an oxygen-carrying protein found in muscle tissue), and chlorophyll (a photosynthetic plant pigment).

- The indole and pyridine rings are found in many alkaloids, which are naturally occurring compounds with one or more nitrogen containing heterocyclic rings. Alkaloids include cocaine, nicotine, quinine, morphine, heroin
- The pyrrole ring is a component of the porphyrin ring found in hemoglobin and chlorophyll
- The imidazole ring is a component of cimetidine, a drug used in the treatment of stomach ulcers

4.2 Classification of Heterocyclic Compounds



4.3 Antibiotics

Antibiotics are medications, also known as antibacterial. Antibiotics are used in the treatment, and prevention of bacterial infections. Antibiotics can inhibit growth of bacteria, or destroy other microorganisms at very low concentrations.

4.4 Types of Antibiotics

1. Synthetic antibiotics

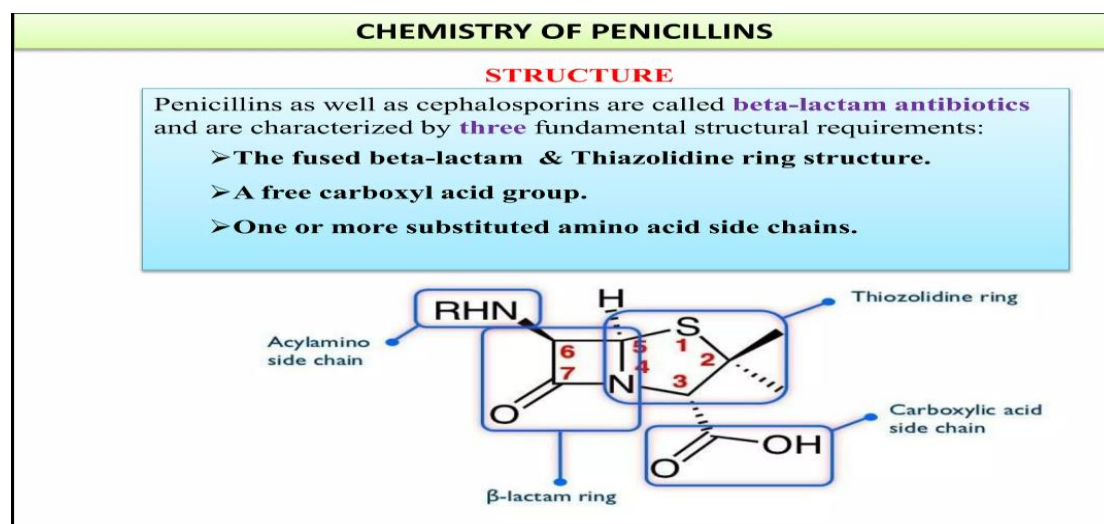
Synthetic antibiotics are a type of antibiotics synthesized as chemical substances in the laboratory to be used later against harmful microorganisms in our environment, for example Tetracycline's.


2. Antibacterial Antibiotics

Antibacterial drugs are naturally occurring antibiotics produced by a microorganism, i.e. bacteria or fungi, then sent outside its cell to be harmful or kill another microorganism. For example Penicillin.

4.5.1 Penicillin

Antibacterial drug Penicillin is an active antibiotic consisting of a heterocyclic ring called Beta - Lactam Ring attached to one or more sugar (R group). Penicillin is a key to generate other antibiotics by increasing the members in its structures.



Penicillin Structure	R Group	Drug Name
	$-\text{CH}_2-\text{C}_6\text{H}_5$	penicillin G
	$\text{CH}_2-\text{O}-\text{C}_6\text{H}_5$	penicillin V
	$-\text{CH}(\text{NH}_2)-\text{C}_6\text{H}_5$	ampicillin
	$-\text{CH}(\text{NH}_2)-\text{C}_6\text{H}_4-\text{OH}$	amoxicillin
	$\text{CH}_3\text{O}-\text{C}_6\text{H}_3(\text{CH}_3)-\text{OCH}_3$	methicillin

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4.5.2 Mechanism of Penicillin to destroy bacteria

1. Penicillin interferes with Peptidoglycan (a polymer that makes up the cell wall of most bacteria. It is made up of sugars and amino acids, and when many molecules of peptidoglycan joined together, they form an orderly crystal lattice structure. Bacteria are classified as being either Gram-positive or Gram-negative based in differences in the structure of their peptidoglycan cell wall) of bacteria cell wall.
2. The cell wall component of bacteria will be lysis.
3. Irreversible reaction of Penicillin cause inactivation of bacteria growth enzyme Transpeptidase, then undergo cell death.

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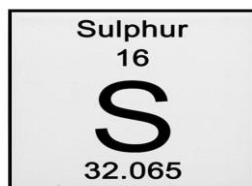
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4.6.1 Sulfur

Sulfur (or Sulphur in [British English](#)). 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.



4.6.2 Importance of sulfur in life

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

6.4.3 Using of Sulfur as Pharmaceuticals:

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