Alkaloids and Heterocyclic Compounds.
Alkaloids

Alkaloids are nitrogenous organic molecules (heterocyclic ring). Derived from plants, animals, and fungi that have significant pharmacological effects on humans and animals. Alkaloids can be classified according to **the starting substances of their biosynthetic pathways**, such as the amino acids that provide nitrogen atoms.

Medical application of Alkaloids

1. Aspirin

Aspirin is alkaloid. The medicinal plants are a rich source of alkaloids having antiplatelet and anticoagulant activities. The commonly used antiplatelet, aspirin, originated from salicin obtained from willow plant commonly used in pain medication.

2. Quinine

Malaria is one of the world's most dangerous parasitic disease and a major public health challenge, especially in Africa. Alkaloid Antimalarial drug Quinine is used to treat malaria. Quinine is used to treat malaria caused by mosquito bites in countries where malaria is common. This medication is used to kill the malaria parasites living inside red blood cells.

3.Omacetaxine

It is a plant alkaloid with antitumor properties originally identified nearly 42 years ago, it has a unique mechanism of action by preventing the initial elongation step of protein synthesis. It has been used widely in China for the treatment of leukemia.

Heterocyclic compound

Heterocycles 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.

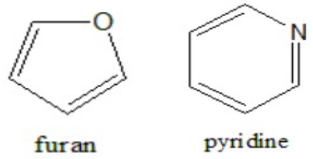

Figure 1: Heterocyclic compound

Classification of Heterocyclic Compounds:

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

1-The five membered heterocyclic compounds.

2-The Six membered heterocyclic compounds.

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.

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 2. 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.

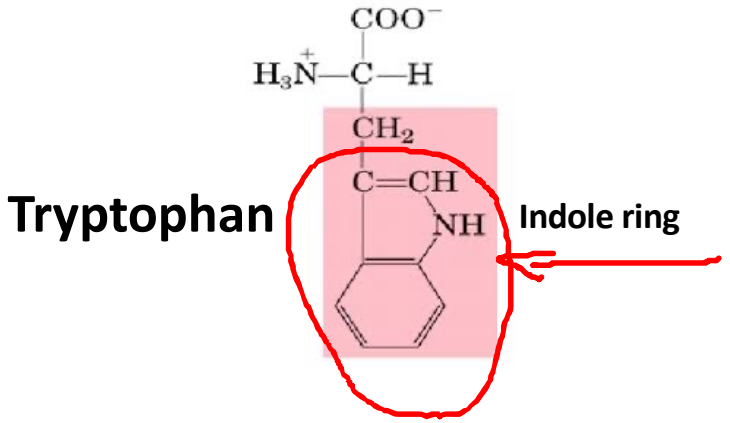

Figure 2: The structure of Indole ring in amino acid L-Tryptophan.

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. In the nucleus DNA, contains the genetic codes to make m-RNA and the m-RNA in turn then contains the codes for the primary sequence of amino acids to make desired protein.

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. For convenience, you may remember, the list of heterocyclic amines in DNA by the words: The Amazing Gene Code (TAGC). **Figure 3**

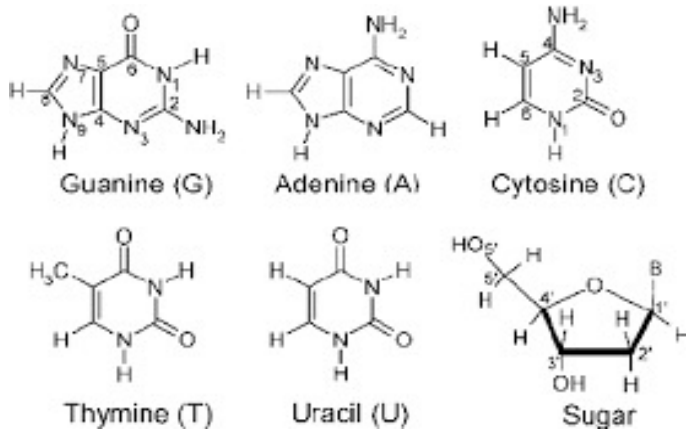

Figure 3: Heterocyclic amines and basis of DNA & RNA

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Nitrogenous bases present in the DNA can be grouped into two categories:

1. Purines (**Adenine** (A) and **Guanine** (G)).
2. Pyrimidine (**Cytosine** (C) and **Thymine** (T).

Diseases Related with DNA Heterocyclic Compounds

Gout in humans

In humans DNA degraded the breakdown occur, by DNA oxidation and the final product of purine metabolism is Uric acid. Uric acid is normally cleaned out of the blood by the kidneys, and passes out of the body along with urine. In severe disorder of purine metabolism, Xanthine oxidized to Uric Acid crystals and deposited in joints as monosodium urate causing acute arthritis joint inflammation, and uric acid is excreted in urine.

Causes of Gout seems to be related to:

Purine rich foods (meat).

Changes in hormones.

Alcohol.

Hereditary influence.

Thiazide diuretics.

The Chemistry of Antibiotics

Drug is a chemical substance used in the treatment, cure, prevention, or diagnosis of disease. They can affect the way of brain works, feelings and behaves, understanding.

These drugs are absorbed into the systemic circulation they bind with certain proteins (involves receptor binding). After that drug receptor binding changes the functioning of the cell slightly.

Human body have trillions of cells about 37.2 Trillion cells. Our skin consist of 35 Billion cells. Some types of these cells only are response to drugs treatment.

A type of cells called **Stem cells** are type of human cells that are able to develop into many different human cell types. This can range from muscle cells to brain cells. In some cases, stem cells can also fix damaged tissues beside antibiotics.

The function of drugs are against :

1- Parasites.

2- Viruses.

3-Bacteria.

4- Fungi.

The difference between Drug and Vaccines

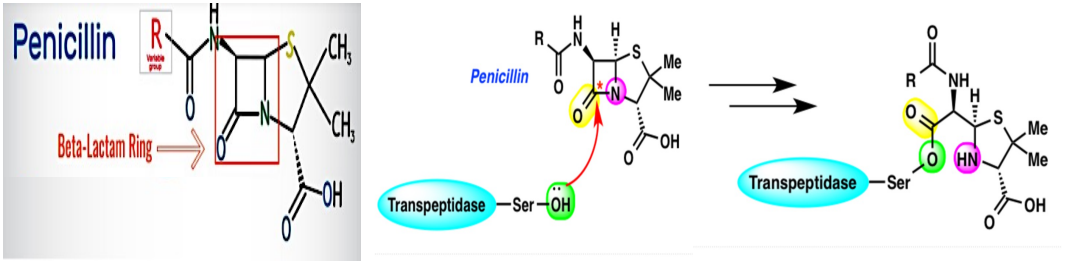
Vaccines are classically administered to prevent the appearance of a medical problem, while drugs are generally administered to treat a medical problem.

Antibiotics:

Antibiotics: are medications, also known as antibacterials. 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.

Penicillin

Antibacterial drug Penicillin is heterocyclic naturally occurring antibiotic produced by a microorganism, i.e. bacteria or fungi, then send outside its cell to be harmful or kill another microorganism. Antibacterial drug Penicillin is an active antibiotic consists 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 membered in its structures. Penicillin interferes with Peptidoglycan of bacteria cell wall.The cell wall component of bacteria will be lysis. Irreversible reaction of Penicillin cause inactivation of bacteria growth enzyme Transpeptidase , then undergo cell death.



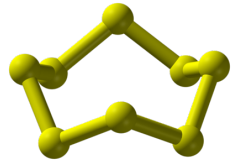
Penicillin and bacteria

Figure 3: Heterocyclic Penicillin

Sulfur

Sulfur is a Heterocyclic Compound.

Sulfur 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. At high concentrations these acids harm the lungs, eyes or other tissues. Sulfur is an essential element for all life.



sulfur (S8).

Sulfur is present in many compounds including

1. Three amino acids Cysteine, Cystine, and Methionine. present in all poly peptides, enzymes and proteins.
2. In intracellular chemistry, sulfur operates as a carrier of reducing hydrogen and its electrons for cellular repair of oxidation. Glutathione is capable of preventing damage to important cellular components.

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.