

Heterocyclic compounds for the sustainability, and existence of human life

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Abstract: Heterocycle are the important precursor of various natural products as well as synthetic drug and hence they acquired significant position in the life of almost all living organisms. In this research paper we are trying to highlights the importance of heterocyclic compounds in the life of living organisms with special reference of human life. Some naturally occurring and some synthetic heterocyclic compounds are discussed in this study.

Keywords: Heterocycles, Biomolecules, Sustainability, existence, living organisms

INTRODUCTION:

[1]Heterocyclic compounds are organic cyclic compounds which contain at least one of the hetero atoms (Nitrogen, Oxygen, Sulphur) other than carbon and hydrogen atoms. The presence of O, N and S atoms in the heterocyclic compounds gives specific characteristics to interact, a variety of interactions like hydrogen bonding, van der Waals interactions, and metal Co-ordination bonds and hence they show wide biological activity. Heterocyclic compounds are abundantly in nature. The body of organism contains a number of heterocyclic compounds and biochemical reactions regulated by various heterocyclic compounds and plays important role in the metabolic process of almost all living organisms. A heterocyclic compound plays a vital role in the physical chemical and biological development of living organisms. The body of plants and animals is composed of biomolecules (carbohydrates, nucleic acids, proteins, fats) which are essential for life and also contain heterocyclic compounds. The structural composition of genetic materials contains heterocyclic bases. DNA and RNA are chemical bases of heredity and variation. They carry genetic information from one generation to another to maintaining the identity of different species of organism for a long period of over millions of years. DNA molecule is capable of self duplication during cell division. Hence the same genetic character is expressed in next generations.

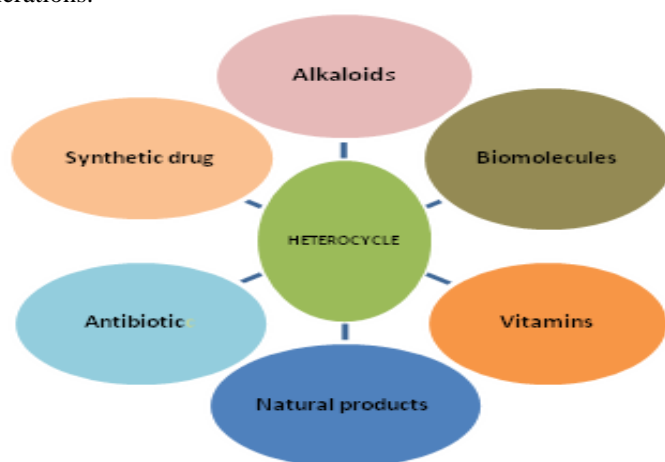


Figure 1: Presence of heterocyclic in various products.

[2]For the sustainability and development of organism including human being on earth it is essential to survive in life. During the life cycle of organism i.e. plants and animals it is need to defend itself against various diseases including infectious, deficiency, heredity and physiological diseases, caused by various pathogens like viral, bacterial, fungal infections or by internal dysfunction. To prevent, treat and cure from the disease it is need to develop medicinal drugs and heterocyclic compounds are the main source of synthetic drug, [3]according to various statistics, about 85 percent of all biologically active chemical compounds contains a heterocycles. [4]In the other word overall almost all synthetic heterocyclic compounds shows somewhat biological activity like antiviral, antibacterial, antifungal etc.

A) Naturally Occurring Heterocycles:

[5]Carbohydrate, nucleic acids, proteins, and fats are known as biomolecules because they are building block of body of almost all living organism. They contains heterocycles discussed below.

Carbohydrates:

Carbohydrates are the organic molecules which contains sugar, starch and fibers.

- Glucose: The six member cyclic structure of glucose is known as pyranose which is analogous to pyran i.e. α -D-Glucopyranose, β -L-Glucopyranose.
Pyran is a cyclic organic heterocyclic compound which contains one oxygen as a hetero atom.

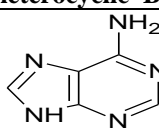
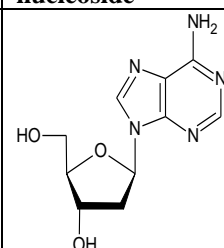
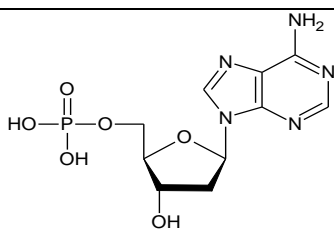
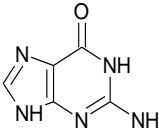
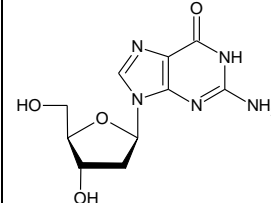
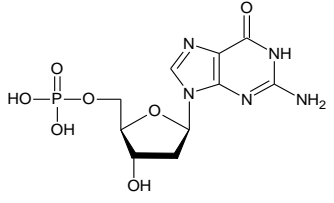
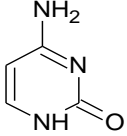
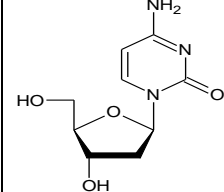
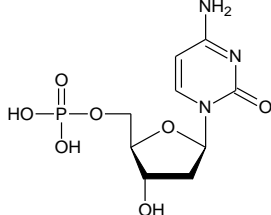
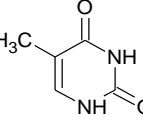
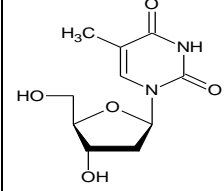
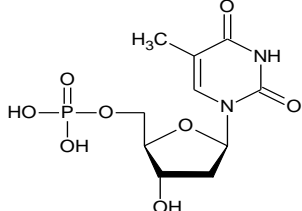
- Fructose: Fructose contains Furan analogous α -D(-) Fructofuranose, β -D(Fructofuranose).

Nucleic Acid:

Nucleic acids is a complex organic substance present in living cells, especially DNA & RNA whose molecules consist of many nucleosides and nucleotides.

- DNA molecule having Oxygen containing heterocycle known as Pentose Sugar and four bases Adenine, Guanine, Cytosine and Thymine is Nitrogen containing Heterocycles.
- RNA also contains four bases Adenine, Guanine, Cytosine and Uracil Nitrogen containing heterocycle.

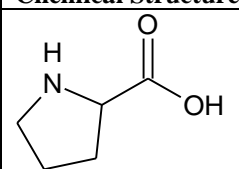
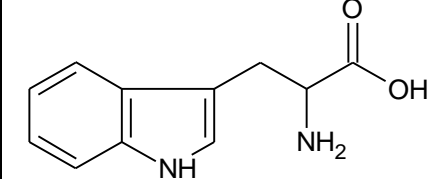
Table: Chemical composition of DNA containing Heterocycles.

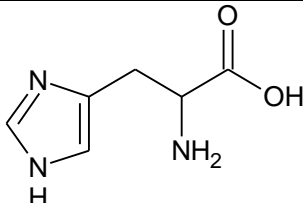
Names of Bases	Structure of heterocyclic Bases	Structure of Deoxyribo-nucleoside	Structure of Deoxyribo-nucleotide
Adenine			
Guanine			
Cytosine			
Thymine			

Natural Amino acids:

[6]Amino acids are the organic compounds which contains amino and carboxyl as main functional groups. Proteins derived from amino acids hence amino acids are the building block of proteins which is very important building block of the body. Protein plays a vital role in the growth and maintenance and development of body. The amino acid Tryptophan, Histidine and Proline are the heterocyclic compounds.

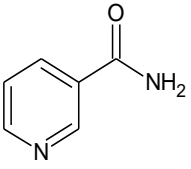
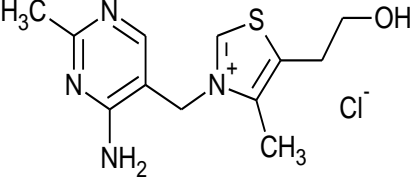
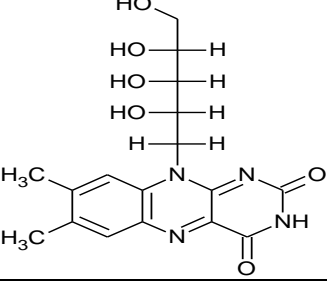
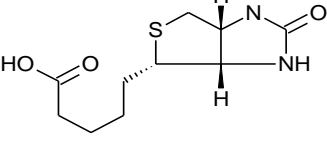
Table: Amino acids containing Heterocycles.

Chemical Structure of Amino acids	Name of amino acids	Functions
	Proline	It plays an important role in cell wall synthesis and plant development, it contribute to the pathogenesis of various diseases caused by various organism
	Tryptophan	Tryptophan helps the synthesis of melatonin and serotonin which helps sleep-wake cycle, neurotransmitter respectively.

	Histidine	Histidine is an essential for synthesis of proteins in living organism.
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Vitamins: [7] Vitamins are organic compounds which are essential micronutrients required in small amounts to properly function the metabolism of living organisms. Some important vitamins containing heterocycles are mentioned in the following table.

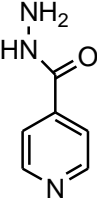
Table: Vitamins containing heterocycles

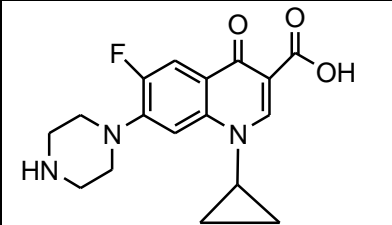
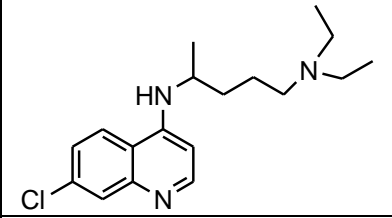
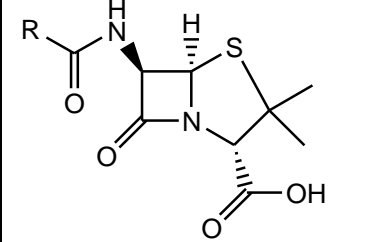
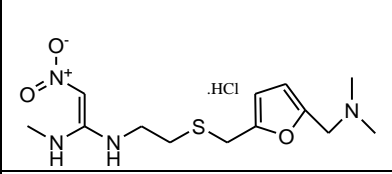
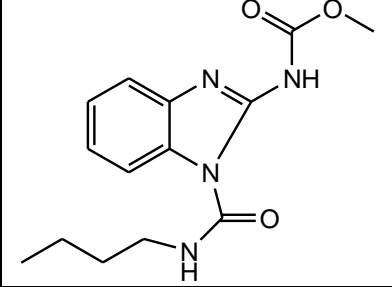
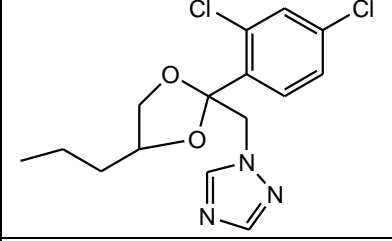
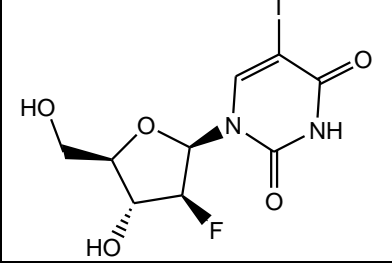
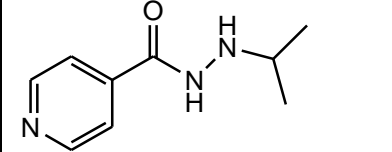
Name of vitamin	Chemical Structure of vitamins	Functions	[8] Effects of deficiency
Vitamin B3 Niacin amide		[8] It helps to convert nutrients which get from food to energy. It helps to lower cholesterol, fats and repair DNA and exerts antioxidant effects.	Depression, Headache, Diarrhea etc.
Vitamin B1 Thiamine chloride		It is essential in the human body for glucose metabolism, i.e., it helps body cells to convert carbohydrates into energy.	Deficiency of vitamin B1 causes beriberi, muscle loss, and peripheral neuropathy.
Vitamin B2 Riboflavin		It helps in red blood cell production in the human body and plays an important role in growth and development of the body.	Deficiency causes brain and heart disorders; long-term deficiency can cause cancer.
Vitamin B7 Vitamin H Biotin		It plays an important role in metabolism and acts as a coenzyme in the transfer of CO2 in important steps in the breakdown of carbohydrates, proteins, and fats into energy.	Deficiency of vitamin B7 causes hair loss and skin problems in humans.

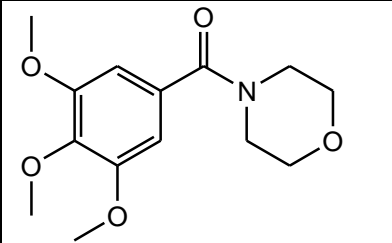
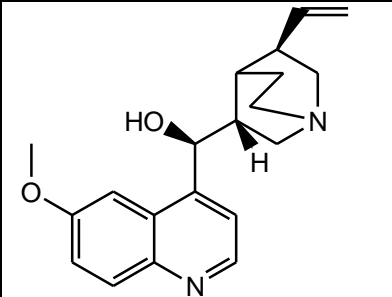
B) Synthetic Heterocyclic compounds

Millions of people in all over the world suffer and die every year due to various types of diseases like Cancer, AIDS, Tuberculosis, etc. and some newly developed viruses like Corona SARS-CoV-2 and some other complex diseases. In the consideration of the need of growing diseases complexity and the demand of a growing population, it is necessary to develop new efficient and cost-effective drugs in the medical field. [9] This growing demand of medical science can be fulfilled by chemical science through the development of research in heterocyclic compounds. Hence, scientists have given special attention to the synthesis and biological evaluation of various heterocyclic compounds. Antipyrine (1887) is the first synthetic drug to reduce fever, and sulfa pyridine (1938) is the first effective antibiotic. Some selected synthetic heterocyclic compounds are discussed as given below in the table.

Table: Synthetic organic heterocyclic Compounds

Biological activity	Chemical Name	Structure	Uses
Antibiotic	Isonicotinic acid hydrazide Isoniazid		[10] Antibiotic used for the treatment of tuberculosis.

Antibiotic	Ciprofloxacin		[11]In the infection of respiratory,urinary track,pneumonia,sinusitis,diahrrea,skin,eyes,abdominal cavities,bones,prostatitis,anthrax etc
Antimalarial	Chloroquine		[12]It is antimalarial drug,used to prevent and treat malaria.
Antibacterial	Beta-lactum		[13]It is used as antibiotic against bacterial infections
Anti-inflammatory	Rantidine		[14]Use to treatment of peptic ulcer,gastroesophageal,reflux disease and zollinger-Ellison syndrome, also used for acid reflux treatment.
Fungicide	Benomyl		[15]Control many plant disease
Fungicide	Propiconazole Triazole		[16]Used in agriculture as a fungicide on turf grasses grown for seed and aesthetic value of food grains.
Antiviral Compound	Fialuridine		[17]Used in disease hepatitis-B
Antidepressant drug	Iproniazid		[18]Used to treat tuberculosis

Sedative agent	Trimetozine		[19]Muscle relaxant, therapeutically used in the treatment of anxiety.
Antimalarial Agent	Quinine		[20]Quinine alkaloid was firstly used to treat malaria in sixteenth century

CONCLUSION:

From above discussion it may be conclude that the heterocyclic compounds plays an important role in the life of organism from the origin of life to the surveillances, sustainability and development of living organism including human being. Heterocyclic compounds also exist naturally as well as synthetically in human life and it is inseparable part of life. A number of species of plants and animals is extinct on the earth from its origin because they cannot defend itself against the infectious diseases like antiviral, antibacterial, antifungal, and non-infectious hereditary diseases but human exist because human continuously develop itself by researching various medicine to treat epidemic disease and heterocycle plays vital role in the research and development of drug to treat and cure diseases.

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