Department Of Chemistry

Udai Pratap Autonomous college Varanasi

Class :- B.Sc.

Semester IInd

Topic :- Chemistry of nucleic acid

Sub Title:- Introduction, Constituents of nucleic acid, Nucleosides and Nucleotides.

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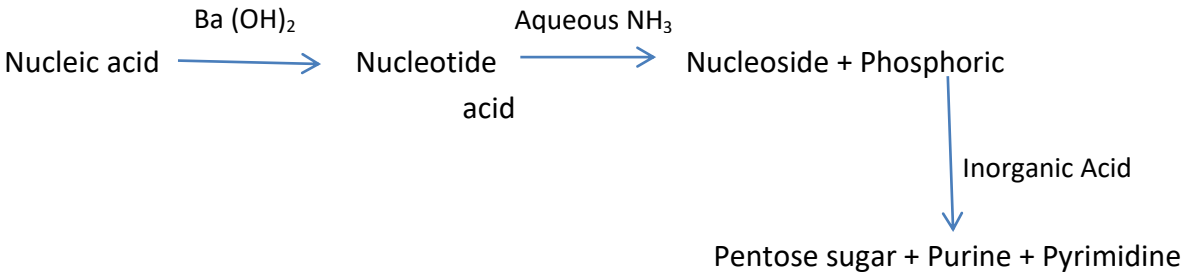
Nucleic Acids

Introduction:-

- Nucleic acids form an important class of compounds ,having high molecular weights.
- They play an important role in the development and reproduction of all forms of life.
- Living cells contains nucleic acids in the form of nucleoproteins.
- Nucleoproteins consist of a protein and nucleic acid.
- Although the name nucleic acid suggests their location in the nuclei of cells, certain of them however present in the cytoplasm.
- It is hereditary determination of living organism.
  According to definition
  "The nucleic acid are biopolymers of high molecular weight with mononucleotide as their repeating units."
  It is same as like amino acid is repeating units of proteins.
- Nucleic acid contains carbons, hydrogen, oxygen , nitrogen and strangely enough phosphorus.
- There are two kinds of amino acids.
  1. Deoxyribonucleic acid Or DNA
  2. Ribonucleic acid or RNA
- Both types of nucleic acids are present in all plant and animals.
- In virus also contains nucleic acid but either DNA or RNA not both.
- DNA found mainly in the chromatin of the cell nucleus whereas most of the RNA (90%) is present in the cell cytoplasm and little (10%) in the nucleolus.
- Nucleic acid on hydrolysis gives a nucleotide which on further hydrolysis gives nucleoside and phosphoric acid.
- Nucleoside in the presence of inorganic acid gives a mixture of sugar, purine and pyrimidine's.

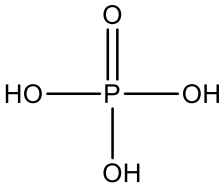


Constituent of Nucleic acids

Structural components of RNA and DNA is

Components	**Ribonucleic acid**	**Deoxyribonucleic acid**
Acid	Phosphoric acid	Phosphoric acid
Pentose sugar	D- ribose	D2- deoxyribose
Nitrogenous base		
Purine	Adenine , Guanine	Adenine , Guanine
Pyrimidines	Cytosine, Uracil	Cytosine, thymine

Phosphoric acid :-The molecular formula of phosphoric acid H_3PO_4. It contains three monovalent hydroxyl groups and a divalent oxygen atom , all linked to the pentavalent phosphorus atom.

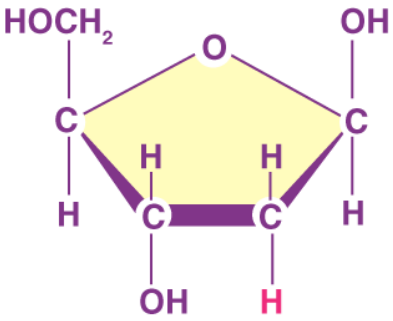


Phosphoric acid

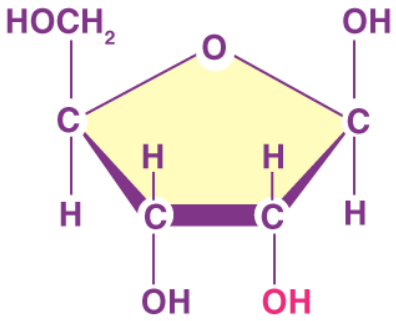
Pentose sugar:-

The two types of nucleic acids are distinguished primarily on the basis of the five carbons keto sugar or pentose which they possess. One possess D-2-deoxyribose, hence name deoxyribonucleic acid (DNA) and other possess D-ribose hence name ribonucleic acid (RNA) .

1. Sugar in nucleic acid are present in the furanose form and are the β − configuration.

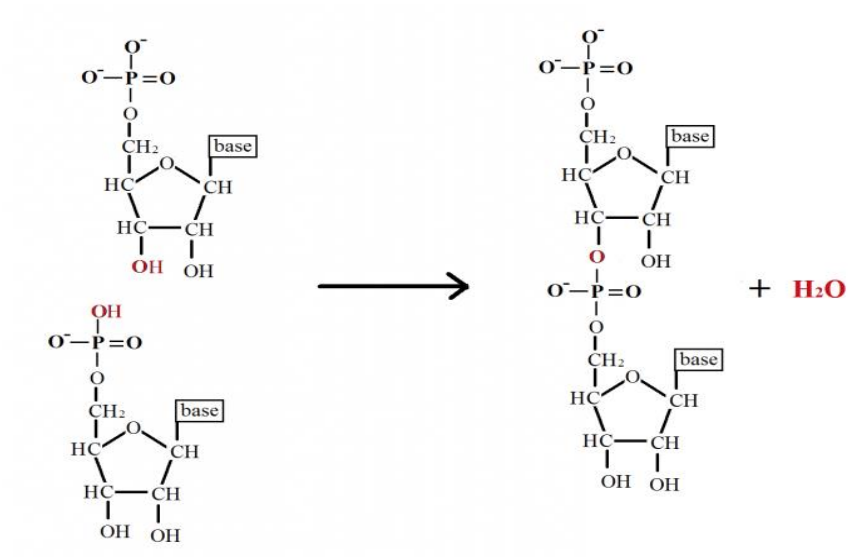


2- Deoxyribose



Ribose

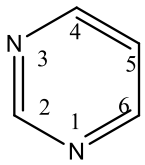
The important properties of pentose are their capacity to form esters with phosphoric acid.



Nitrogenous bases

Two types of nitrogenous bases are found in all nucleic acid. They are derivatives of pyrimidine and purine.

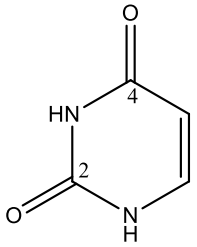
Pyrimidine Derivatives:- These all are derivatives of their 'Parent heterocyclic compounds of pyrimidine'.



Pyrimidine

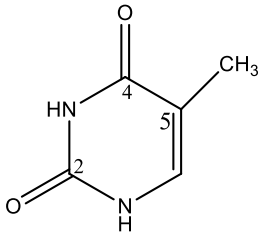
The common pyrimidine derivatives of uracil, thymine and cytosine.

1- **Uracil ($C_4H_4O_2N_2$):-**It is found in RNA molecules only , is a white crystalline pyrimidine base MW=112.10 dalton and melting point 338° C



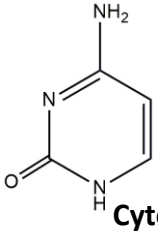
Uracil (2, 4 dioxypyrimidine or pyrimidinedione)

2- **Thymine($C_5H_6O_2N_2$) :-** Found in DNA molecules only. W MW=126.13. It is first isolated from thymus hence name thymine.



Thymine (5-methyl, 2,4-dioxypyrimidine or 5-methyl uracil

3- Cytosine ($C_4H_5ON_3$) :- Found in both DNA and RNA. It is white crystalline substance with MW=111.12 Daltons melting point 320-325°c .

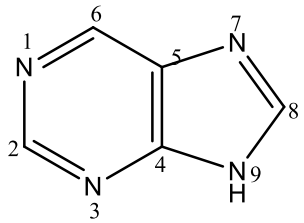


Cytosine

(4-amino-2-oxypyrimidine or amino pyrimidine)

Purine Derivatives

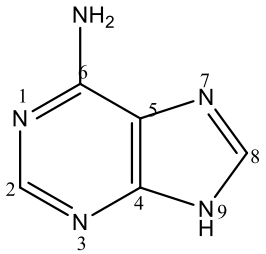
These all are derived from their parent compounds purine which contains a six membered pyrimidine ring fused to a five membered imidazole ring.



Purine

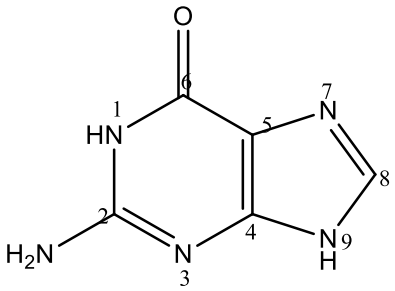
Purine derivatives are Adenine and Guanine.

Adenine ($C_5H_5N_5$) :- Found in both DNA and RNA. It is white crystalline purine base M.W.=135.15 dalton. M.P.= 360-365°C



Adenine (6- aminoPurine)

Guanine ($C_5H_5ON_5$):- Also found in RNA and DNA ,is colourless, insoluble crystalline substance. M.W.= 151.15 dalton. It is first isolated from guano (bird manure) hence name.



Guanine (2-amino6 oxypurine)

Nucleosides

"Nucleoside are compounds in which nitrogenous bases (purines and Pyrimidine) are conjugated to the pentose sugsr (ribose or deoxyribose) by a β-glycosidic linkage."

- The $\beta -$ glycosidic linkage involves the C-1 of sugar and hydrogen atom of N-9 (in case of purine) or N-1 (in case of pyrimidines) ,thus eliminate the water molecules.
- Nucleosides are stable in the alkali but hydrolysed in the acid.

Naming Or Nomenclature

- Nucleosides are generally named for the particular purine or pyrimidine present.
- Nucleoside which contains ribose sugar are called ribonucleoside whereas deoxyribose as deoxyribonucleoside.

Ribonucleoside

Base	Sugar	Nucleoside	Trival Name
Adenine	Ribose	Adenine ribonucleoside	Adenosine
Guanine	Ribose	Guanine ribonucleoside	Guanosine
Cytosine	Ribose	Cytosine ribonucleoside	Cytidine
Thymine	Ribose	Thymine ribonucleoside	Thymidine
Uracil	Ribose	Uracil ribonucleoside	Uridine

Deoxyribonucleoside

Base	Sugar	Nucleoside	Trival name
Adenine	Deoxyribose	Adenine deoxyribonucleoside	Deoxyadenosine
Guanine	Deoxyribose	Guanine deoxyribonucleoside	Deoxyguanosine
Cytosine	Deoxyribose	Cytosine deoxyribonucleoside	Deoxycytidine
Thymine	Deoxyribose	Thymine deoxyribonucleoside	Deoxythymidine

Uracil	Deoxyribose	Uracil deoxyribonucleoside	Deoxyuradine

If two or three phosphate linkage are there with each other phosphoric acid thus we use di or tri instead of mono.

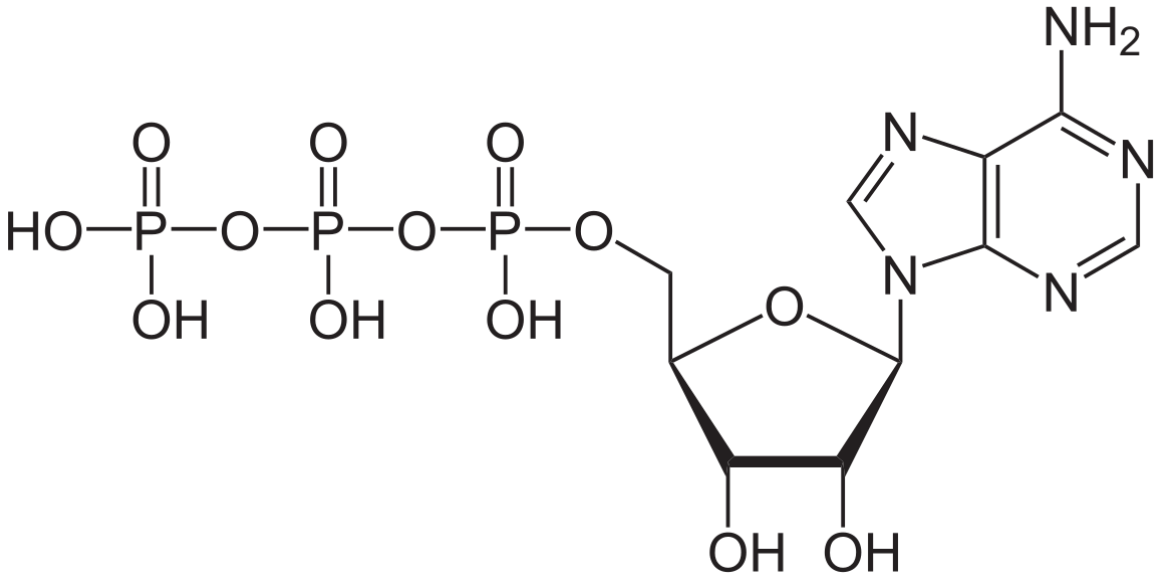
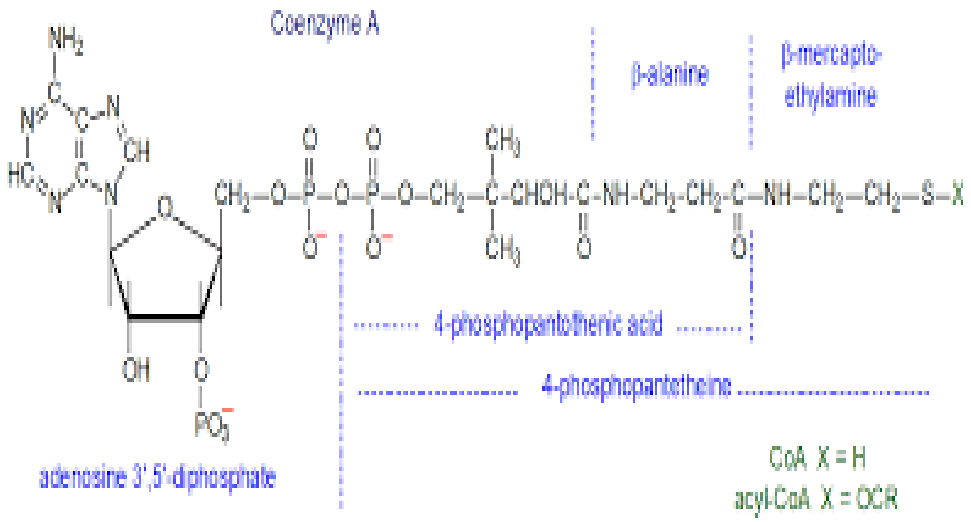


Fig. Structure of Adenosine tri phosphate (ATP)

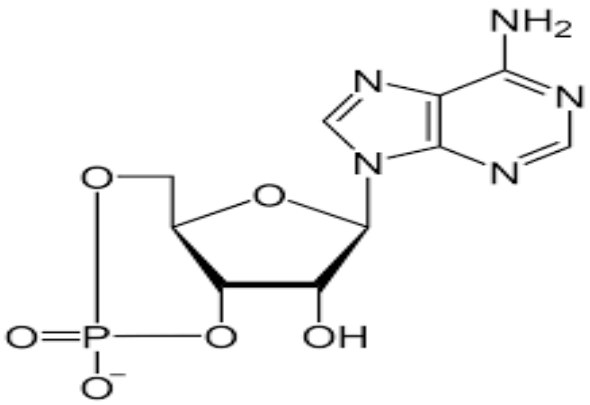
Function of Nucleotides:-

1- **As Carrier of Chemical energy**:- In nucleotides 1,2 or 3 phosphate groups may be covalently bounded at c-5 of ribose forming respectively mono, di or triphosphate (NMP,NDP,NTP) . the triphosphate are used as source of chemical energy for many biochemical reaction . ex. Adenosine triphosphate (ATP).

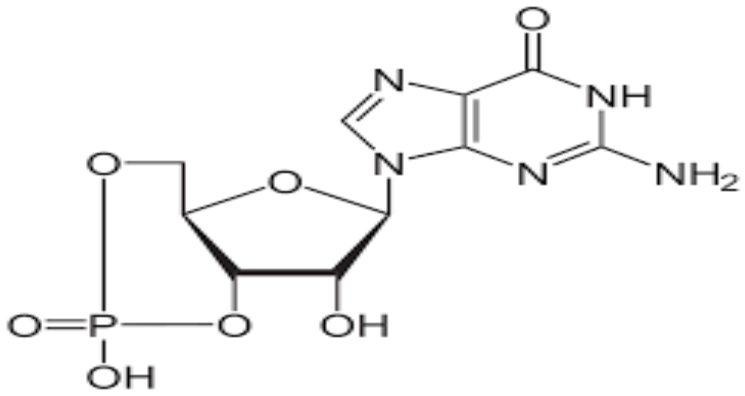
2-Component of enzyme Factors:- Many enzyme cofactors and coenzymes (such as coenzyme A, NAD^+ FAD) contain adenosine as part of their structure. They differs from each others except for the presence of adenosine. In these cofactors adenosine does not participate directly but removal of adenosine from these cofactors usually results in drastic reduction of their activity.



- As chemical messangers:- In cells some nucleotide perform the role of secondary messengers eg. Adenosine 3’-5’ cyclic monophosphate formed from ATP in the reaction catalysed by adenylate cyclase, associated with the inner phase of the plasma membrane , other example Guanosine 3’-5’ cyclic monophosphate (CGMP).



Adenosine 3’-5’ cyclic monophosphate (C AMP)



Guanosine 3’- 5’ cyclic monophosphate (C GMP)