Chemistry of Nucleic Acid

Introductory Microbiology (BSH-114)

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Chemistry of Nucleic Acids

Nucleic Acids - Definition

- Nucleic acids are a long chain or polymer of repeating subunits, called nucleotides.
- Each nucleotide subunit is composed of three parts:
  - A five-carbon sugar
  - a phosphate group
  - a base (**Phoebus A. Levene 1920**)

- **DNA (deoxyribonucleic acid) polymer of nucleotides linked in a chain through phosphodiester bonds.**
- In biological systems, they serve as information-carrying molecules

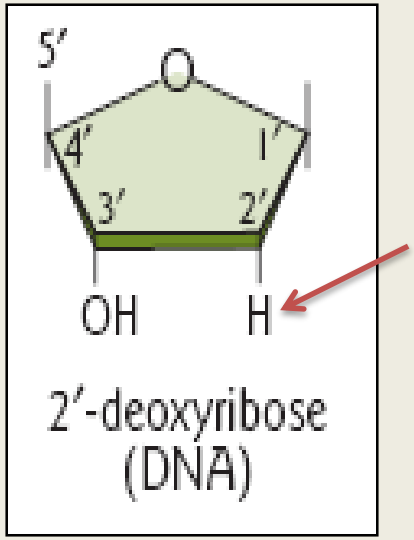
- **RNA (ribonucleic acid) polymer of nucleotides linked in a chain through phosphodiester bonds**
- In biological systems, they serve catalysts

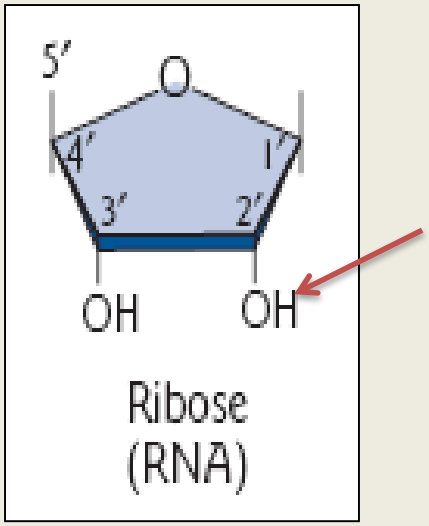
DNA vs.RNA

- Double stranded
- Sugar = deoxyribose
- Thymine (no Uracil),**Thymidine**
- Stays in nucleus
- One type
- Same copy in the cell all the time

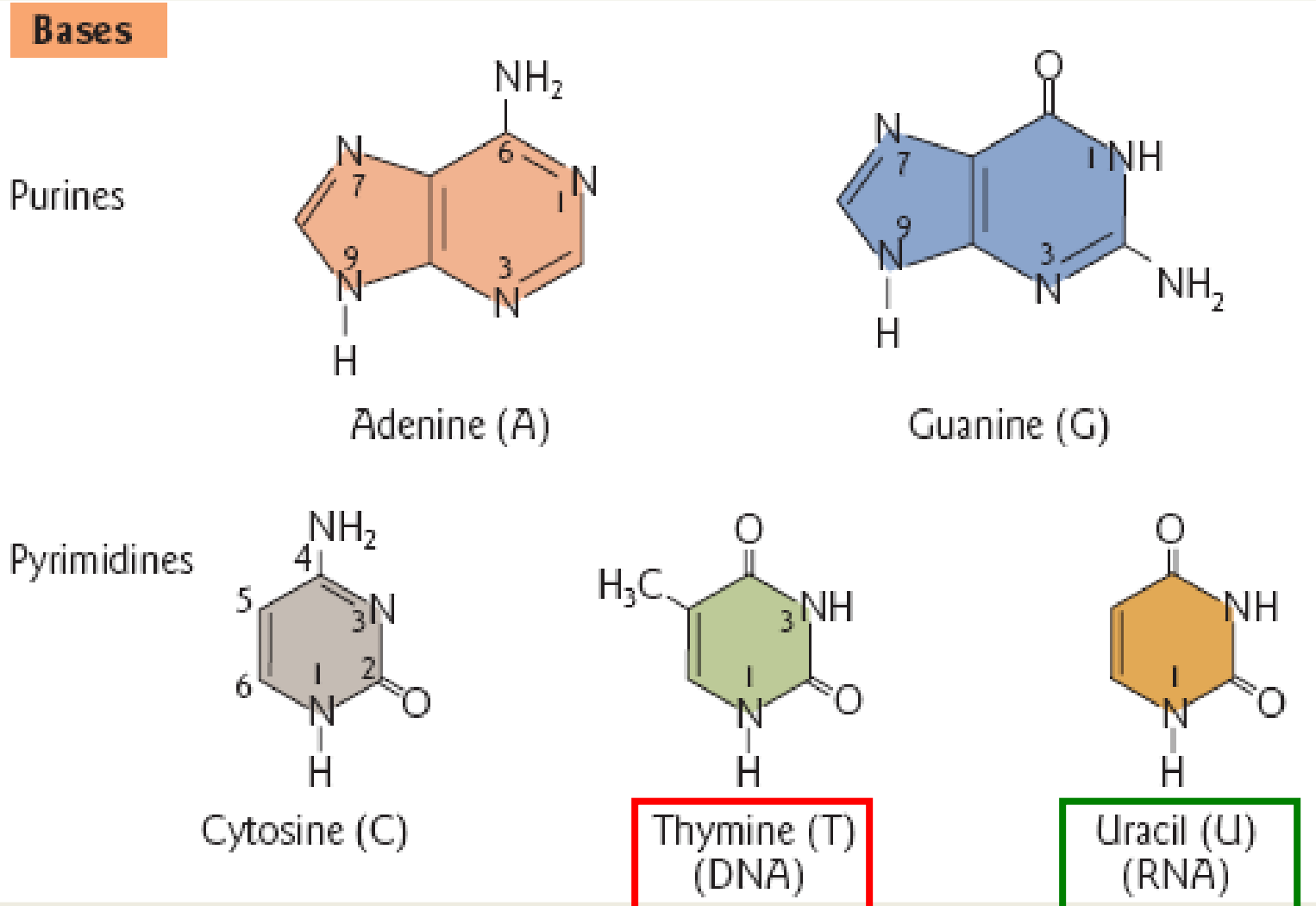
- Single stranded
- Sugar = ribose
- Uracil (instead of Thymine) **Uridine**
- Nucleus & cytoplasm
- 3 types (mRNA, tRNA, rRNA)
- Disposable copies

Sugars

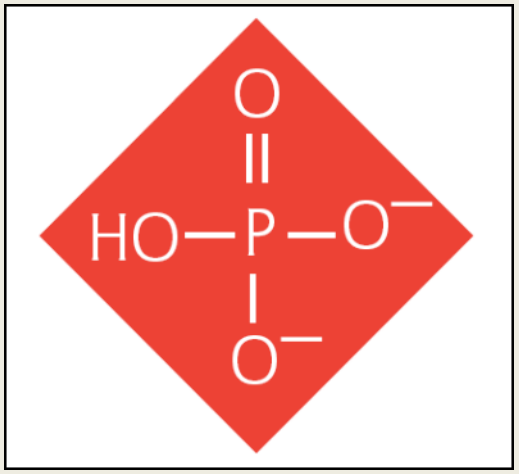




Primary structure: the components of nucleic acids

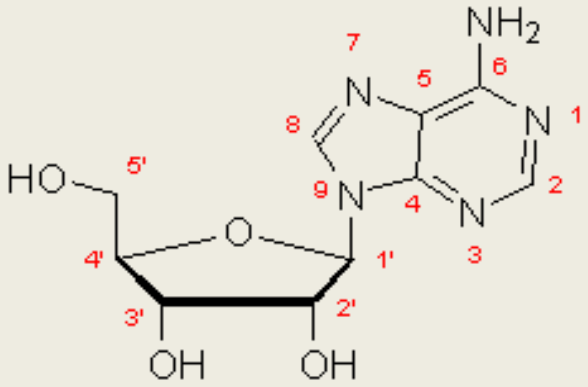
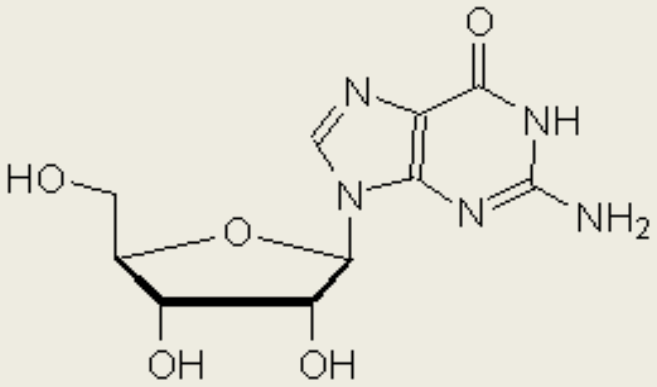
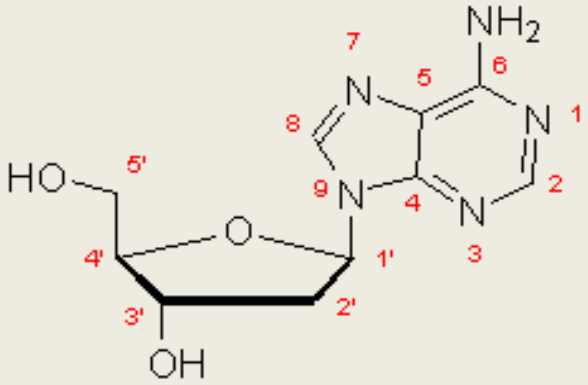
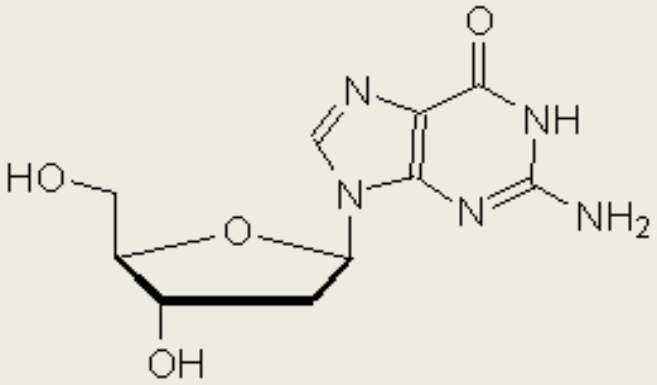


Phosphate Functional Group

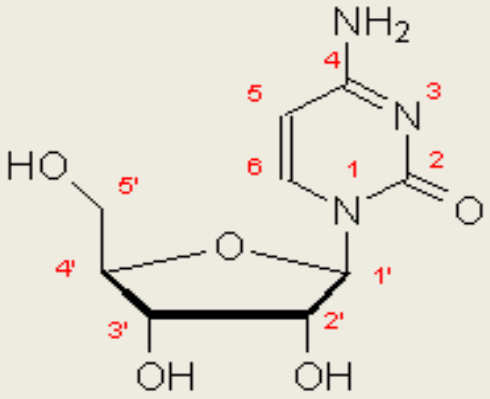
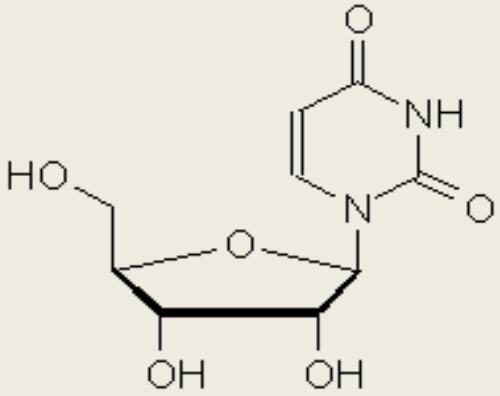
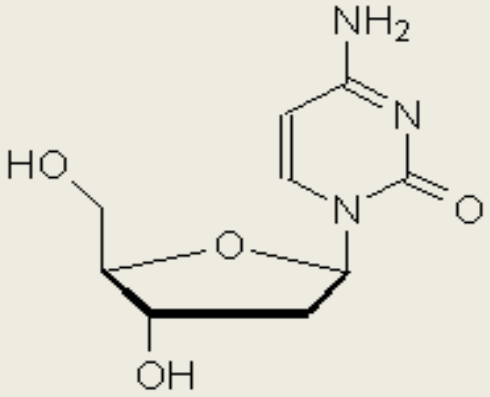
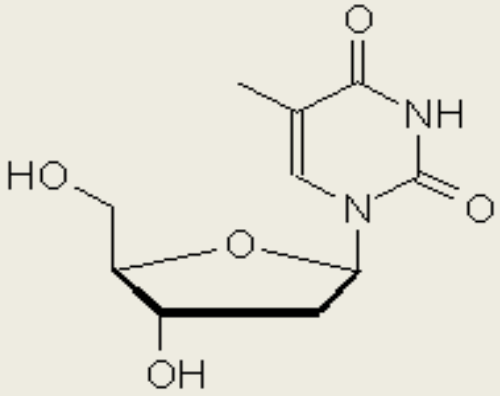


- The phosphate functional group (PO_4) gives DNA and RNA the property of an acid (a substance that releases an H+ ion or proton in solution) at physiological pH, hence the name “nucleic acid.”
- The linking bonds that are formed from phosphates are esters that have the additional property of being stable, yet are easily broken by enzymatic hydrolysis. When a nucleotide is removed from a DNA or RNA chain, the nucleotide is not destroyed in the process. Further**, after the phosphodiester bond is formed, one oxygen atom of the phosphate group is still negatively ionized.**
- The negatively charged phosphates are extremely insoluble in lipids, which ensures the retention of nucleic acids within the cell or nuclear membrane.

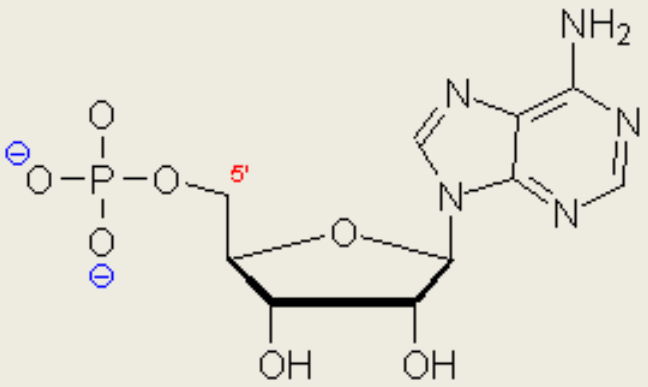
Structure of Purine Nucleosides

Adenosine	Guanosine
	
Deoxyadenosine	**Deoxyguanosine**
	

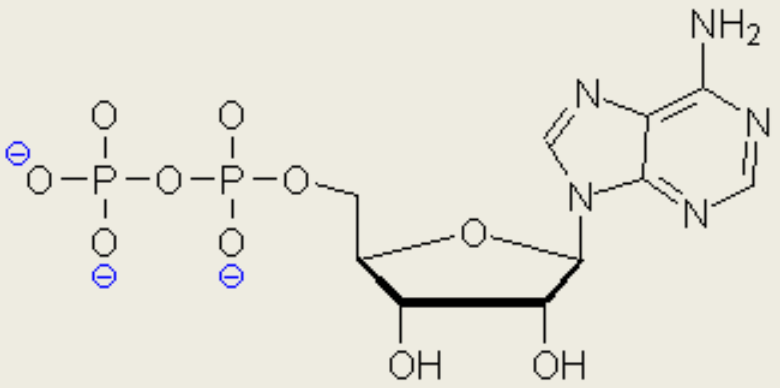
Structure of Pyrimidine Nucleosides

Cytidine	Uridine
	
Deoxycytidine	**Thymidine (Deoxythymidine)**
	

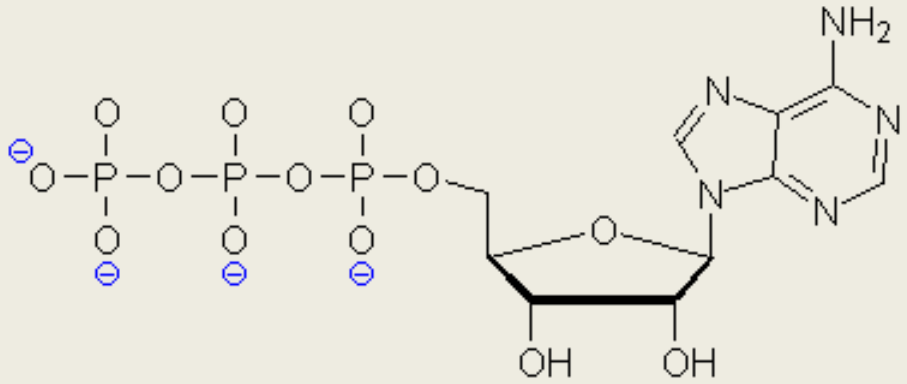
AMP,ADP and ATP



Adenosine 5'-monophosphate
(AMP)

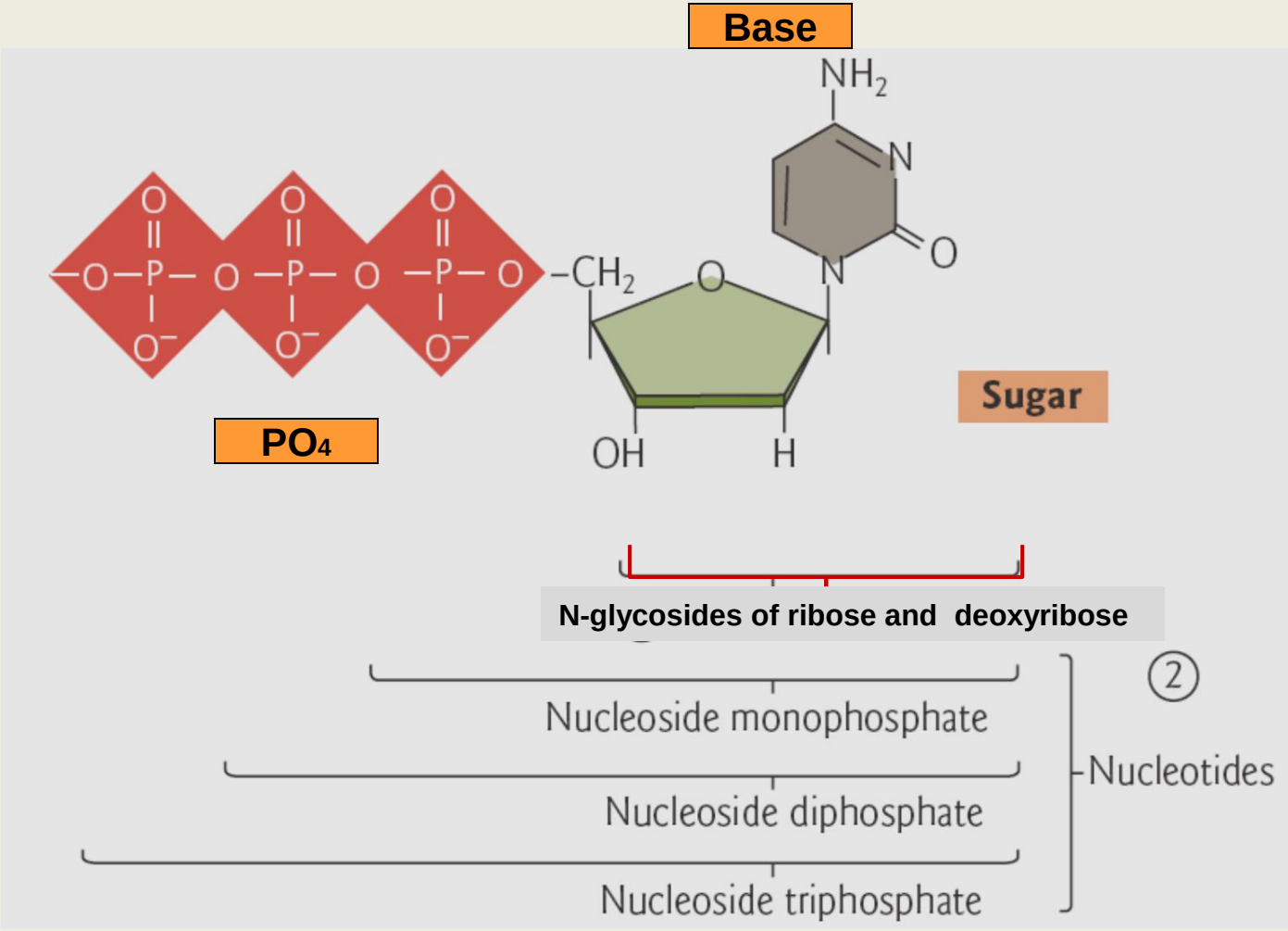


Adenosine 5'-diphosphate
(ADP)

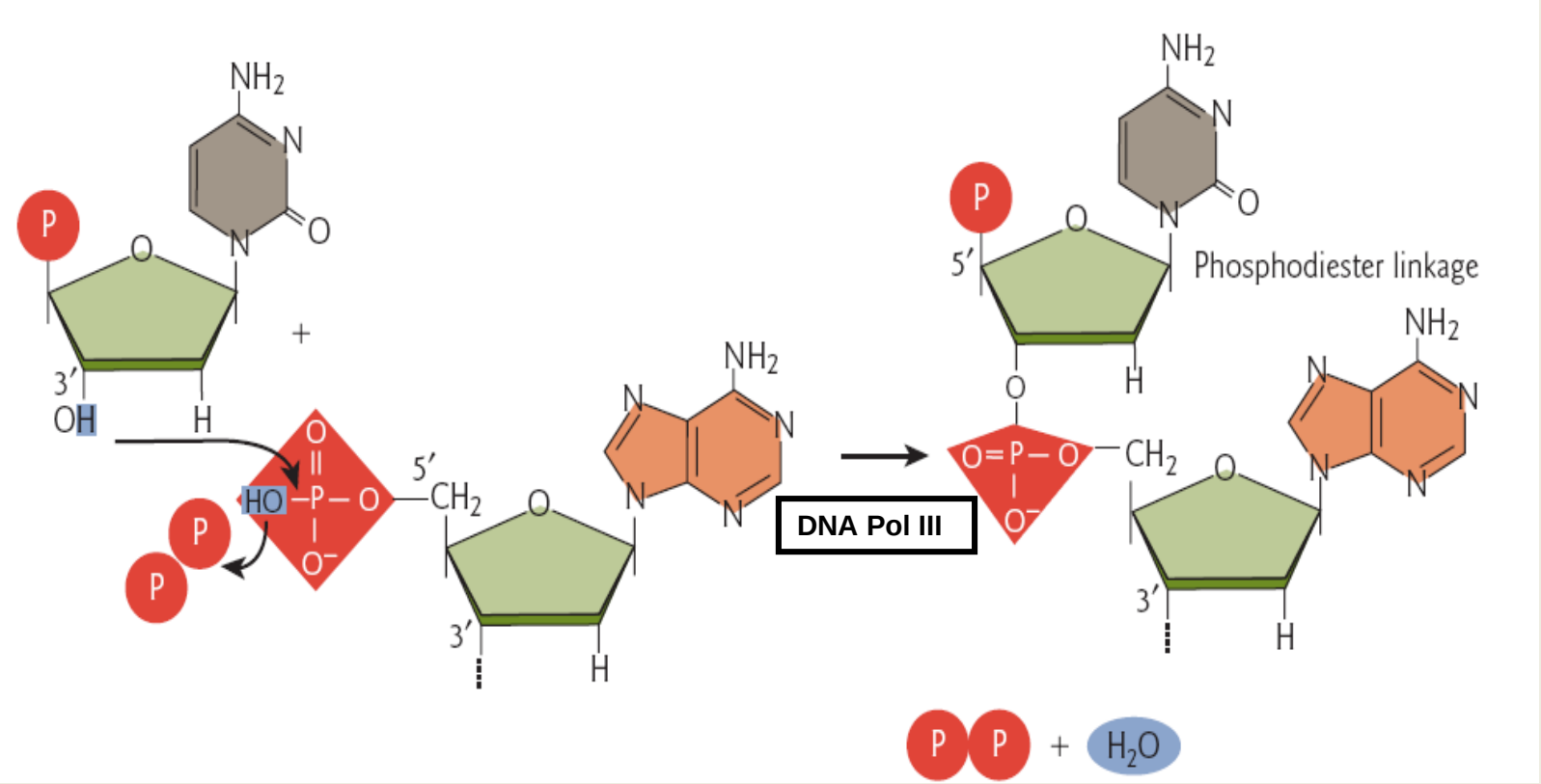


Adenosine 5'-triphosphate
(ATP)

Nucleosides and Nucleotides



Formation of Nucleic Acids



Nomenclature of nucleotides

Base	Nucleoside		Nucleotide*	
	DNA	RNA	DNA	RNA
Adenine (A)	Deoxyadenosine	Adenosine	Deoxyadenosine 5′-triphosphate (dATP)	Adenosine 5′-triphosphate (ATP)
Guanine (G)	Deoxyguanosine	Guanosine	Deoxyguanosine 5′-triphosphate (dGTP)	Guanosine 5′-triphosphate (GTP)
Cytosine (C)	Deoxycytidine	Cytidine	Deoxycytidine 5′-triphosphate (dCTP)	Cytidine 5′-triphosphate (CTP)
Thymine (T)	Deoxythymidine	–	Deoxythymidine 5′-triphosphate (dTTP)	–
Uracil (U)	–	Uridine	–	Uridine 5′-triphosphate (UTP)
Generic (N)	Deoxynucleoside	Nucleoside	Deoxynucleoside 5′-triphosphate (dNTP)	Nucleoside 5′-triphosphate (NTP)

*** Nucleotides may contain one phosphate unit (monophosphate), two such units (diphosphate), or three (triphosphate). The triphosphate form shown in the table serves as the precursor building block for nucleic acid synthesis.**