Nucleic Acid

- First isolated by Swiss biochemist Fredrich Miescher in 1969 from nucleus of pus cells.
- Named it nuclein.
- Termed nucleic acid by Altman because of its acidic nature.
- Nucleic acids are of two types : Deoxyribonucleic acid (DNA) and Ribonucleic acid (RNA).
- Upon complete hydrolysis nucleic acid yields following three compounds :
  1. Nitrogenous compounds
  2. Pentose sugar and
  3. Phosphates

  1. **Nitrogenous bases** belong to two groups –

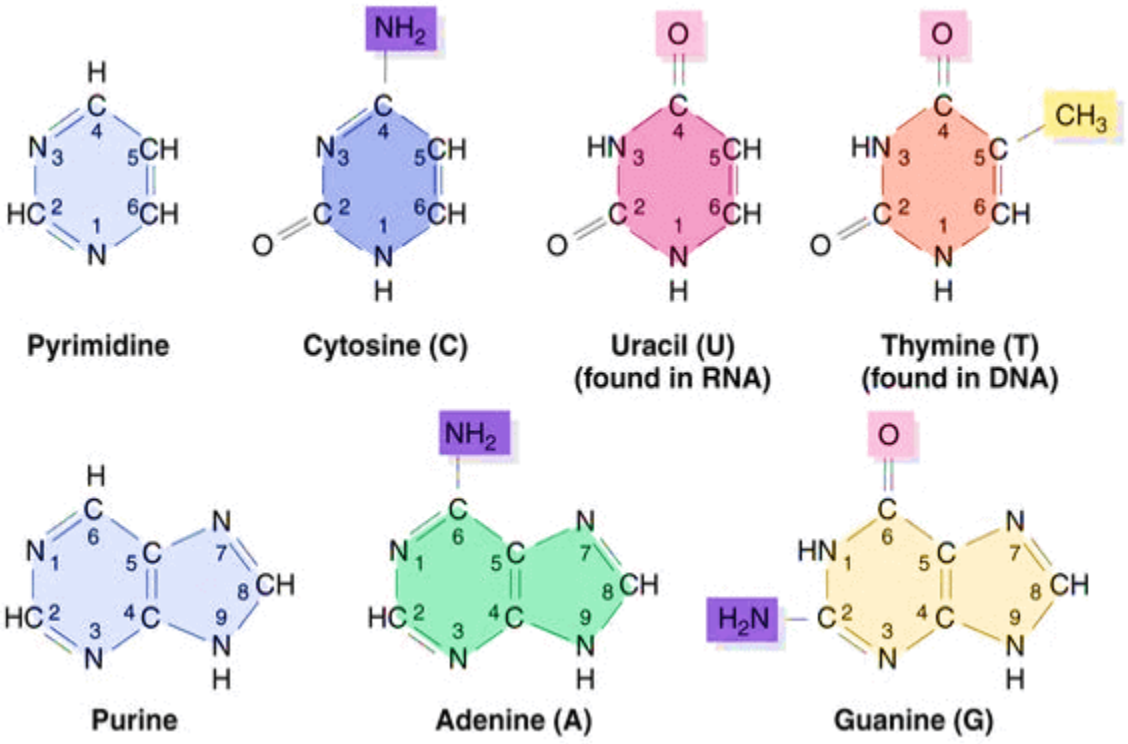
  (a) **Purine** –These are 9 member ring of carbon and nitrogen atoms. Two types - **Adenine (A) and Guanine (G).**

  (b) **Pyrimidines** – 6 member ring of C and N atoms. Three types – **Cytosine (C), Uracil (U) and Thymine (T)**

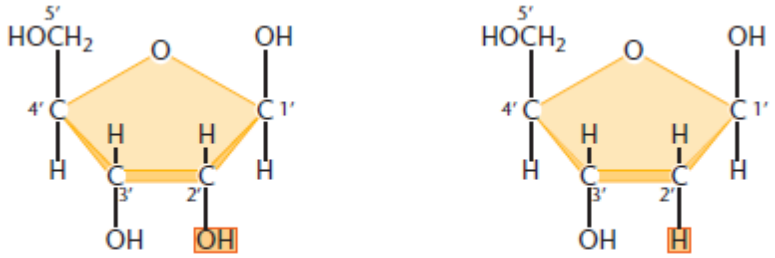
  In DNA adenine, thymine, cytosine and guanine are present where as in RNA uracil is present in place of thymine.

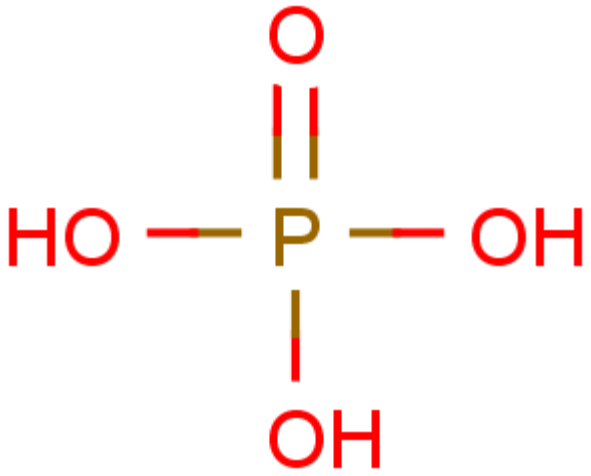
  2. Pentose sugar – Five carbon sugar in a ring form called β-furanose ring. These are of two types – **Ribose sugar and Deoxy ribose sugar.** Numbers in pentose sugar are given a prime (1'). Only difference in these two sugars is that ribose sugar contains **-OH** group at 2' position whereas in deoxy ribose sugar there is H in place of OH at 2'.

  3. Phosphates : It is in the form of Phosphoric acid. Acidic nature of DNA and RNA is because of the presence of phosphates.


Pyrimidine
Cytosine (C)
Uracil (U)
(found in RNA)
Thymine (T)
(found in DNA)
Purine
Adenine (A)
Guanine (G)

(b)


Ribose
2-Deoxyribose



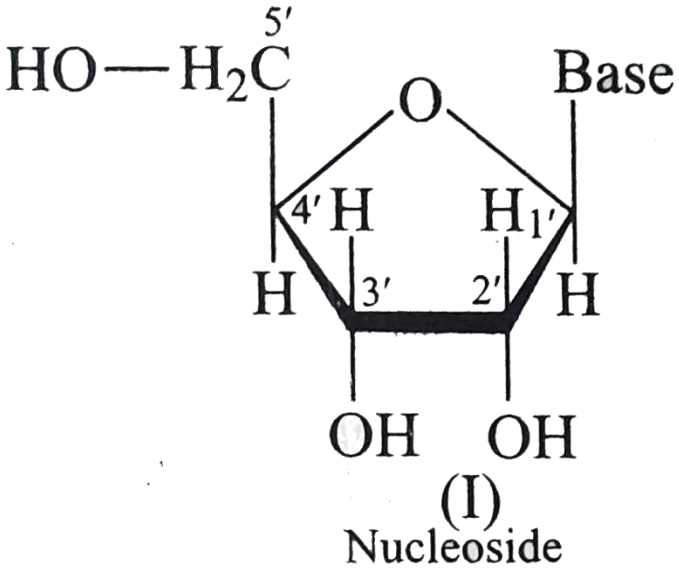
Phosphate in the form of phosphoric acid

These residual compounds are arranged in three levels of organization :

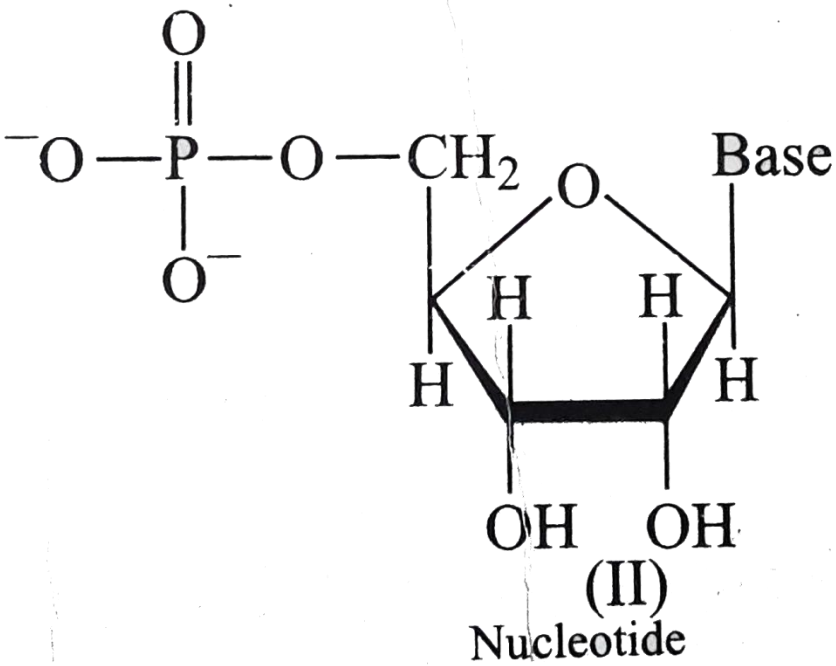
First level of organization is nucleoside which is formed by the association of **pentose sugar and nitrogenous bases**. They are joined by the formation of **glycosidic bond** between C1' of sugar and $\mathbf{N_9}$ of purines and $\mathbf{N_1}$ of pyrimidines.

Second level of organization is nucleotide which is the basic unit of nucleic acid, both DNA and RNA. These are formed by the joining of phosphoric acid to the nucleoside at the 5'C of the

pentose sugar by **easter bond.**

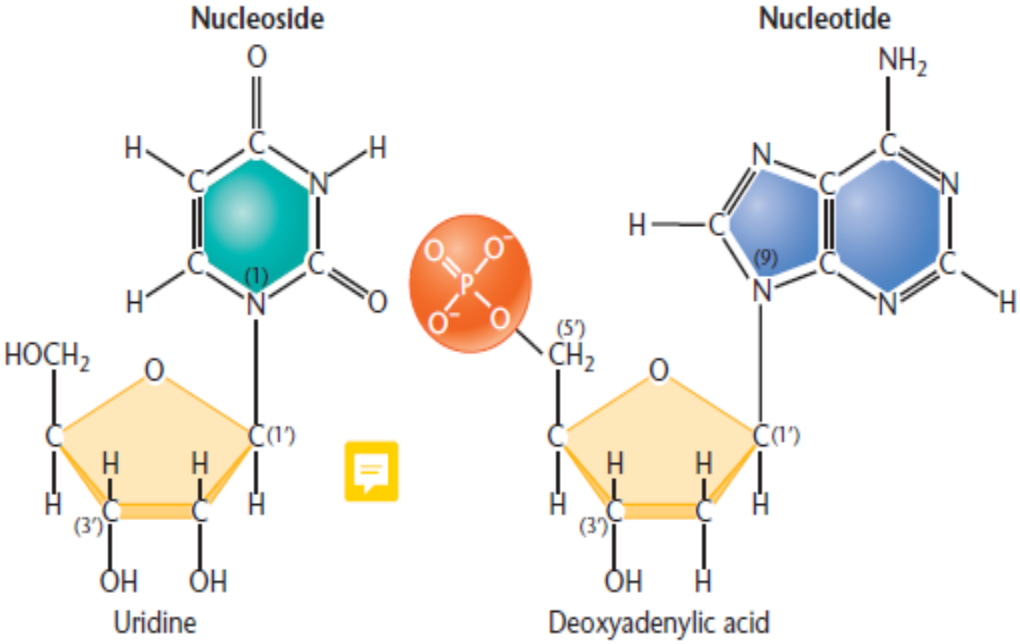


(I)
Nucleoside



(II)
Nucleotide

Since there are five types of N bases, A,T,G,C and U, there are as many types of nucleosides and nucleotides.



Ribonucleosides	Ribonucleotides
Adenosine Cytidine Guanosine Uridine	Adenylic acid Cytidylic acid Guanylic acid Uridylic acid
Deoxyribonucleosides	**Deoxyribonucleotides**
Deoxyadenosine Deoxycytidine Deoxyguanosine Deoxythymidine	Deoxyadenylic acid Deoxycytidylic acid Deoxyguanylic acid Deoxythymidylic acid

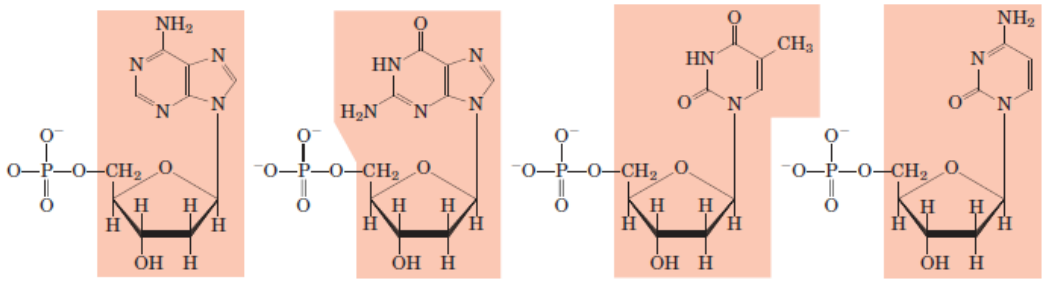
Structures and names of the nucleosides and nucleotides of RNA and DNA.

TABLE 8–1 Nucleotide and Nucleic Acid Nomenclature

Base	Nucleoside	Nucleotide	Nucleic acid
Purines			
Adenine	Adenosine	Adenylate	RNA
	Deoxyadenosine	Deoxyadenylate	DNA
Guanine	Guanosine	Guanylate	RNA
	Deoxyguanosine	Deoxyguanylate	DNA
Pyrimidines			
Cytosine	Cytidine	Cytidylate	RNA
	Deoxycytidine	Deoxycytidylate	DNA
Thymine	Thymidine or deoxythymidine	Thymidylate or deoxythymidylate	DNA
Uracil	Uridine	Uridylate	RNA

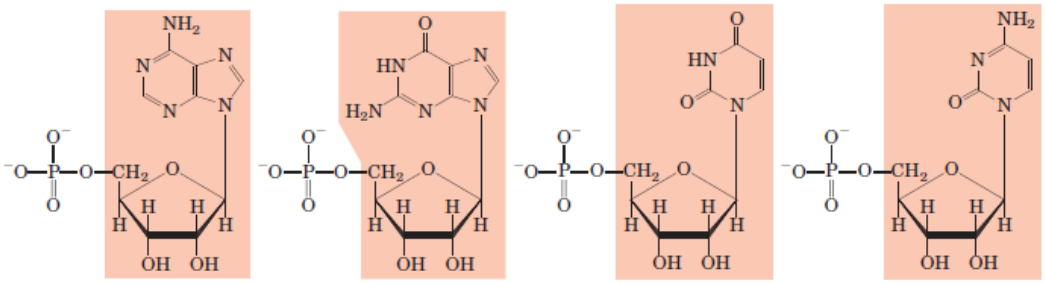
Note: "Nucleoside" and "nucleotide" are generic terms that include both ribo- and deoxyribo- forms. Also, ribonucleosides and ribonucleotides are here designated simply as nucleosides and nucleotides (e.g., riboadenosine as adenosine), and deoxyribonucleosides and deoxyribonucleotides as deoxynucleosides and deoxynucleotides (e.g., deoxyriboadenosine as deoxyadenosine). Both forms of naming are acceptable, but the shortened names are more commonly used. Thymine is an exception; "ribothymidine" is used to describe its unusual occurrence in RNA.

Third and final level of organization is polynucleotide which is formed by the joining of nucleotides by phospodiester bonds. During its formation, 3'OH of a nucleotide joins with 5'P of the next nucleotide and 3'OH of this nucleotide forms phosphodiester bond with 5'P of the next one. In this way, a chain of nucleotides called polynucleotide is formed. 5'P of the first nucleotide and 3'OH of the last nucleotide remains free which are called 5'P end and 3'OH end respectively.



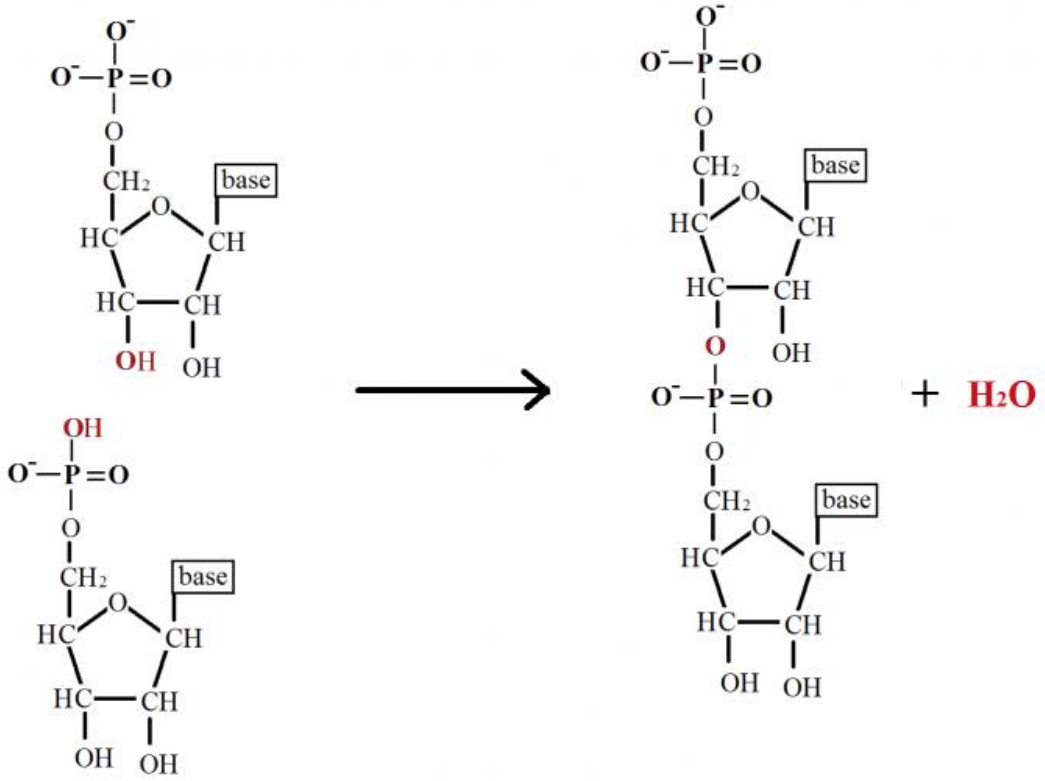
Nucleotide:	Deoxyadenylate (deoxyadenosine 5′-monophosphate)	Deoxyguanylate (deoxyguanosine 5′-monophosphate)	Deoxythymidylate (deoxythymidine 5′-monophosphate)	Deoxycytidylate (deoxycytidine 5′-monophosphate)
Symbols:	A, dA, dAMP	G, dG, dGMP	T, dT, dTMP	C, dC, dCMP
Nucleoside:	Deoxyadenosine	Deoxyguanosine	Deoxythymidine	Deoxycytidine

(a) Deoxyribonucleotides



Nucleotide:	Adenylate (adenosine 5′-monophosphate)	Guanylate (guanosine 5′-monophosphate)	Uridylate (uridine 5′-monophosphate)	Cytidylate (cytidine 5′-monophosphate)
Symbols:	A, AMP	G, GMP	U, UMP	C, CMP
Nucleoside:	Adenosine	Guanosine	Uridine	Cytidine

(b) Ribonucleotides


O⁻
O⁻—P=O
O
CH₂
base
HC
O
CH
HC
CH
OH
OH
OH
O⁻—P=O
O
CH₂
base
HC
O
CH
HC
CH
OH
O
O⁻—P=O
O
CH₂
base
HC
O
CH
HC
CH
OH
OH
+ H₂O

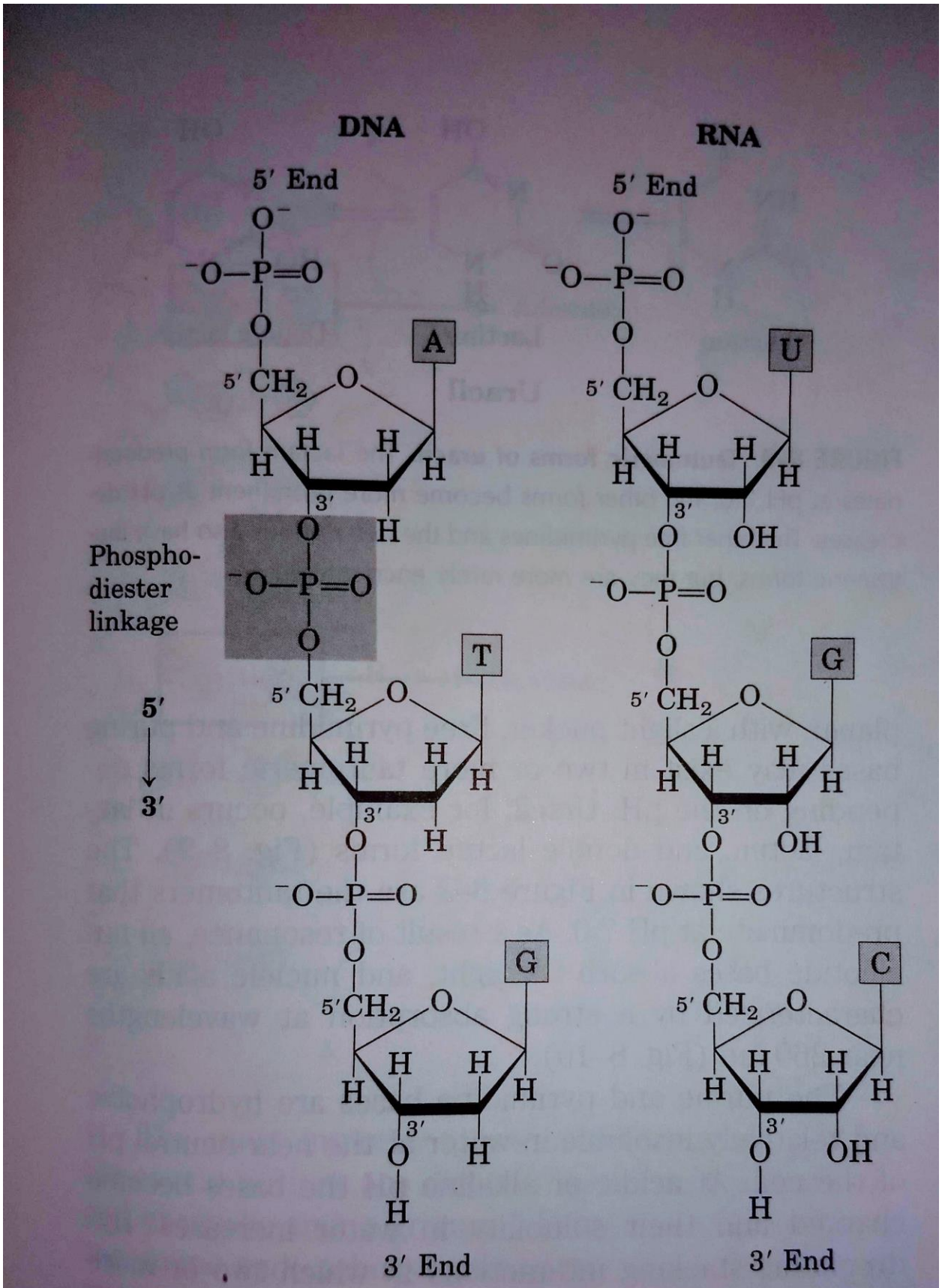


FIGURE 8–7 Phosphodiester linkages in the covalent backbone of DNA and RNA. The phosphodiester bonds (one of which is shaded in the DNA) link successive nucleotide units. The backbone of alternating pentose and phosphate groups in both types of nucleic acid is

Alternating sugar-phosphates is called sugar-phosphate backbone from which bases stick out.
Conventionally base sequence of a polynucleotide is written in 5’- 3’ direction, from left to right, e.g., 5’ATG 3’ (in the given above fig.)

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