

Structure and function of DNA

Structure and Function of Nucleic Acid

- **Two types of nucleic acid are present in the cell**
- **Similar primary structure**
- **Three basic components**
 - 1. A nitrogenous base(Purine, Pyrimidine)**
 - 2. Sugar**
 - 3. Phosphate group**

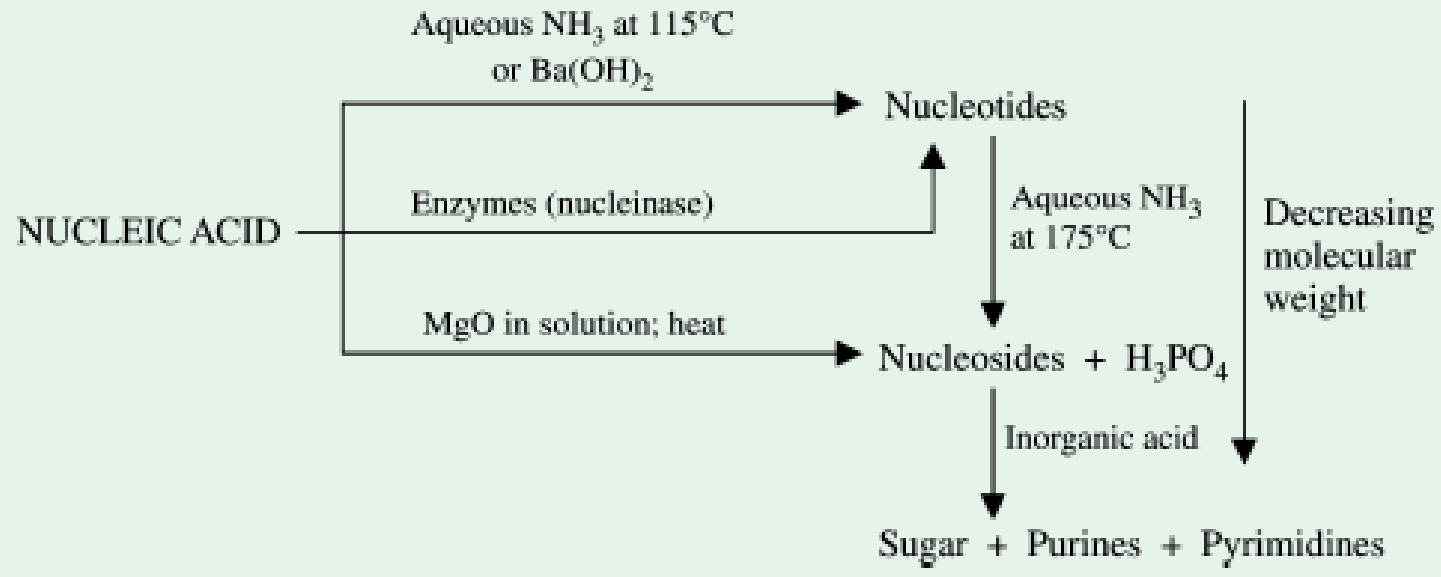
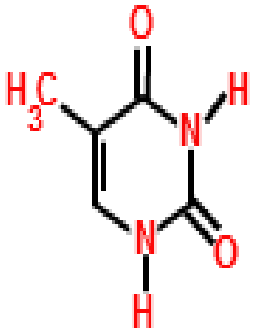
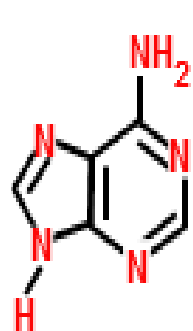
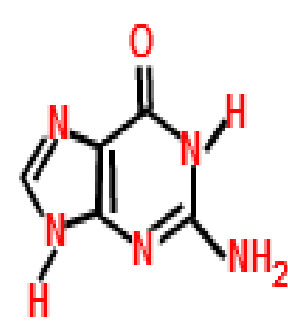
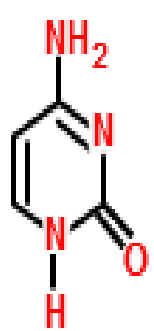
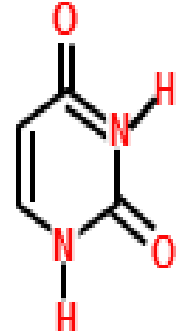
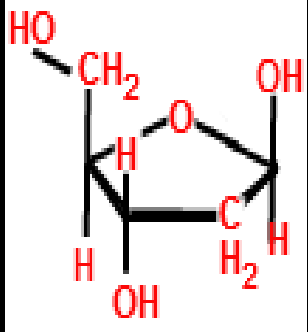
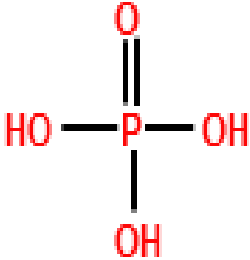
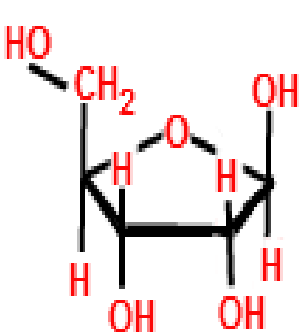
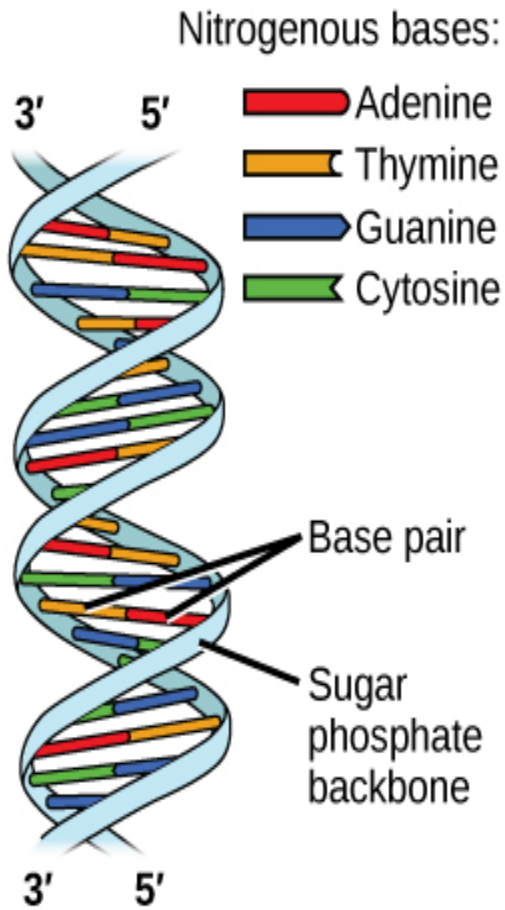


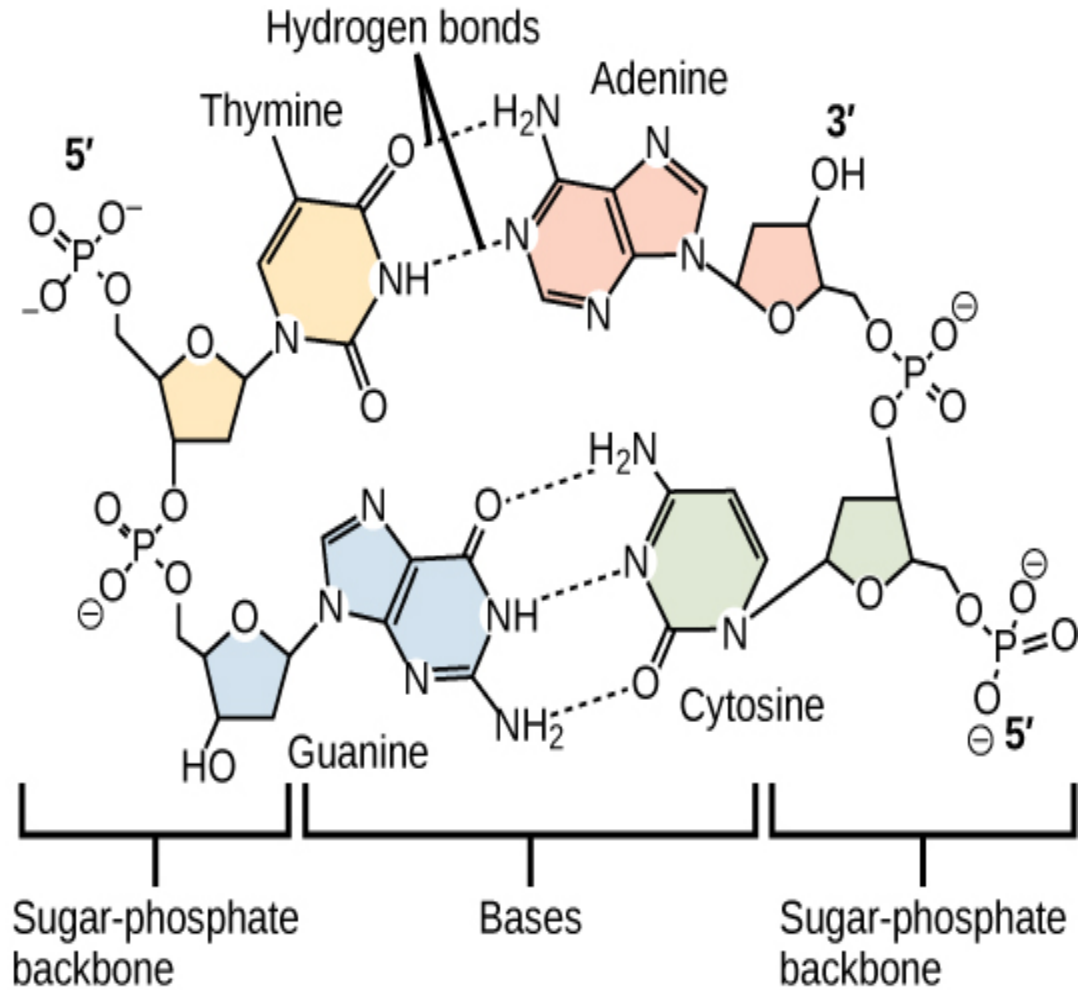
Fig. 15-1. Hydrolytic products of nucleic acid

Components of Nucleic Acids

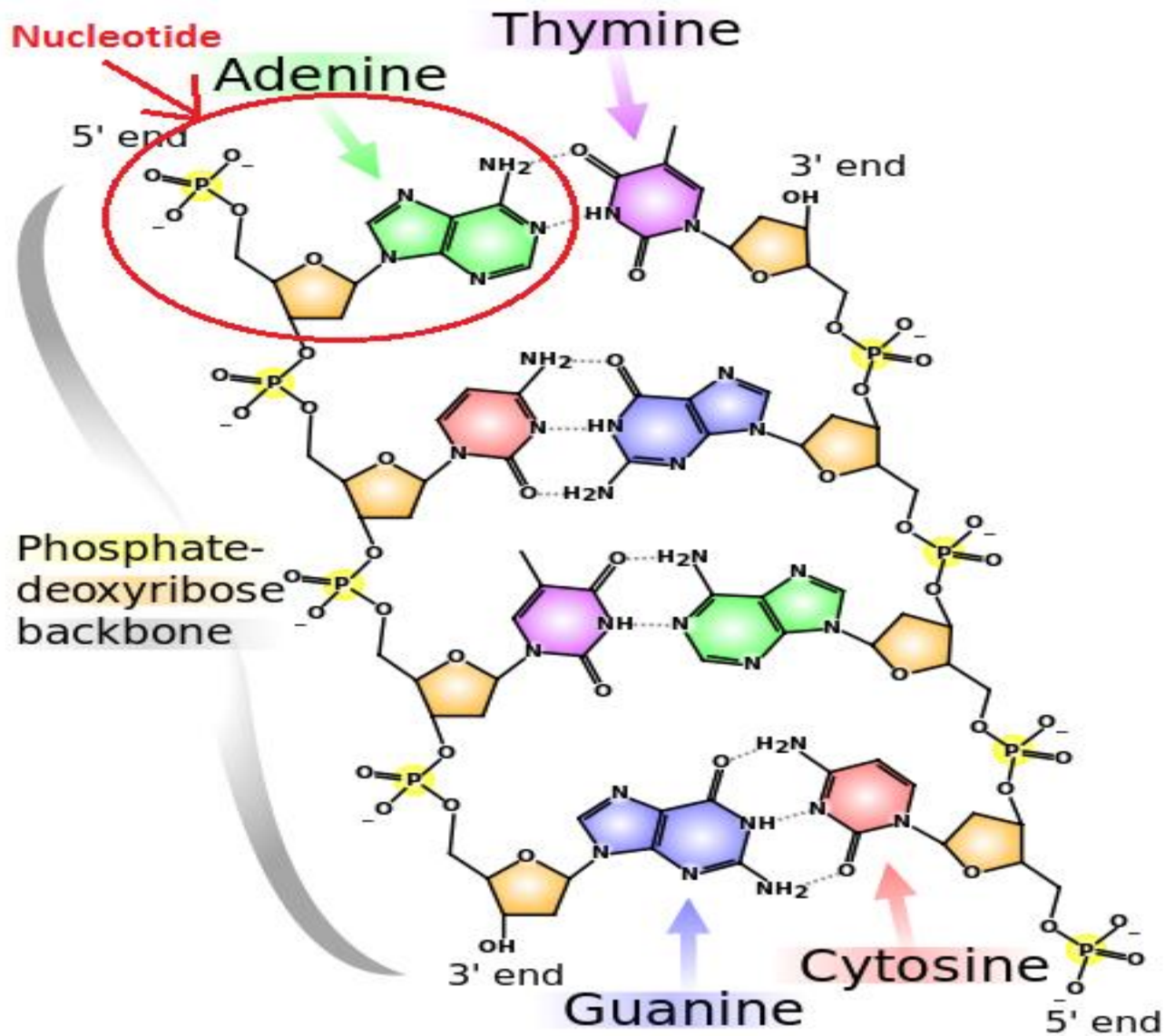
	DNA only	DNA & RNA		RNA only	
Nitrogen bases	 <p>Thymine</p>	 <p>Adenine</p>	 <p>Guanine</p>	 <p>Cytosine</p>	 <p>Uracil</p>
sugar & phosphate	 <p>2-Deoxyribose</p>	 <p>Phosphate</p>		 <p>Ribose</p>	



(a)



(b)



Nomenclature of Nucleic Acid Components

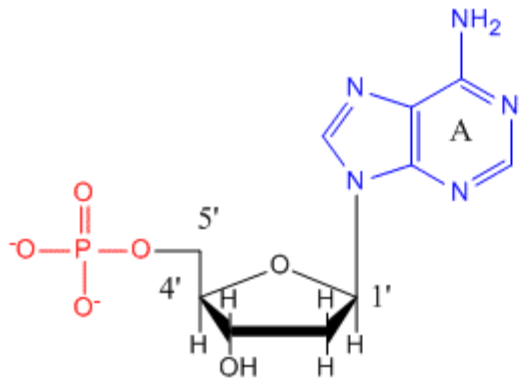
<i>Base</i>	<i>Nucleoside</i>	<i>Nucleotide</i>	<i>Nucleic acid</i>
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Purines

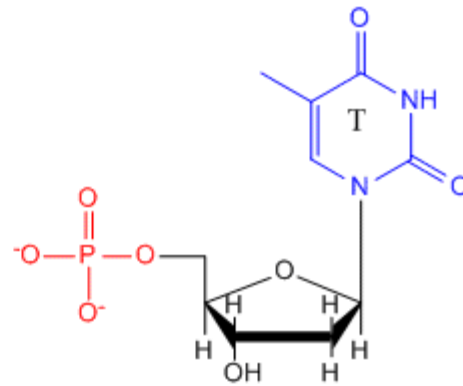
Adenine	Adenosine	Adenylate	RNA
	Deoxyadenosine	Deoxyadenylate	DNA
Guanine	Guanosine	Guanylate	RNA
	Deoxy guanosine	Deoxyguanylate	DNA

Pyrimidines

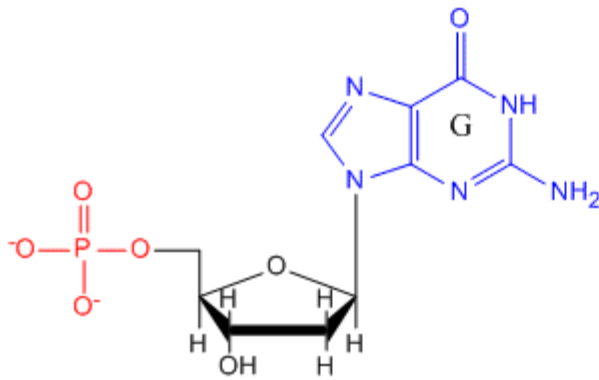
Cytosine	Cytidine	Cytidylate	RNA
	Deoxycytidine	Deoxycytidylate	DNA
Thymine	Thymidine	Thymidylate	DNA
	(deoxythymidine)	(deoxythymidylate)	
Uracil	Uridine	Uridylate	RNA



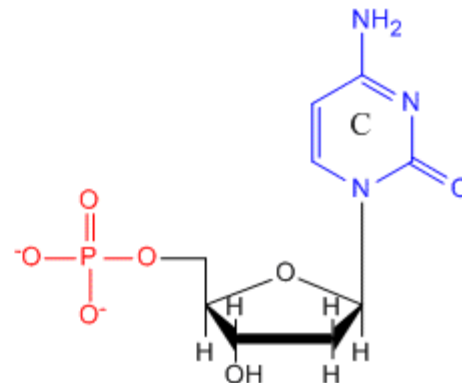
deoxyadenosine 5'-phosphate



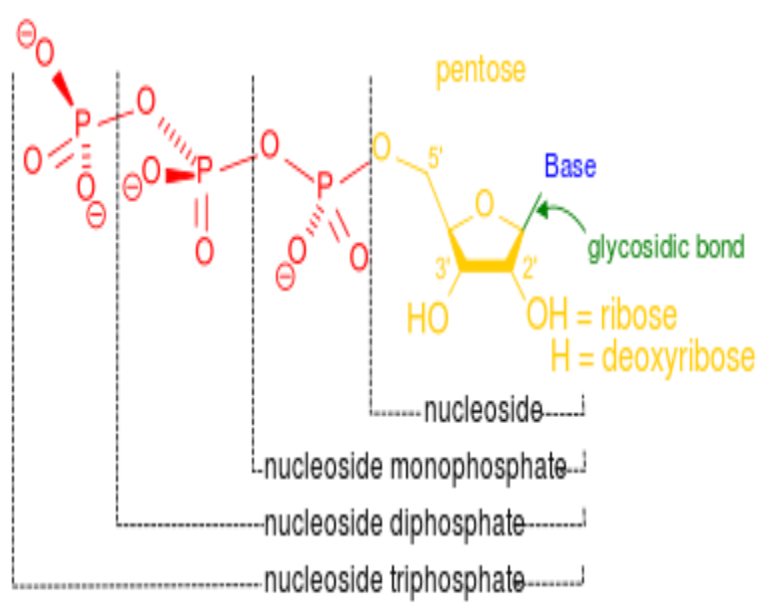
deoxythymidine 5'-phosphate



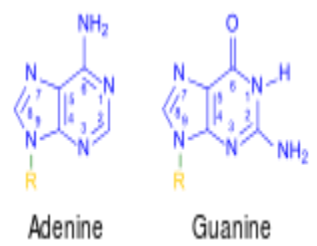
deoxyguanosine 5'-phosphate



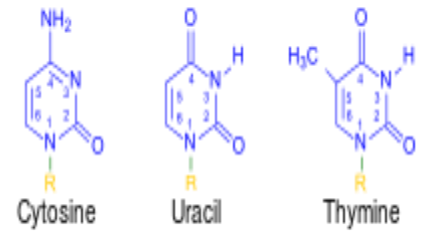
deoxycytosine 5'-phosphate



Purines



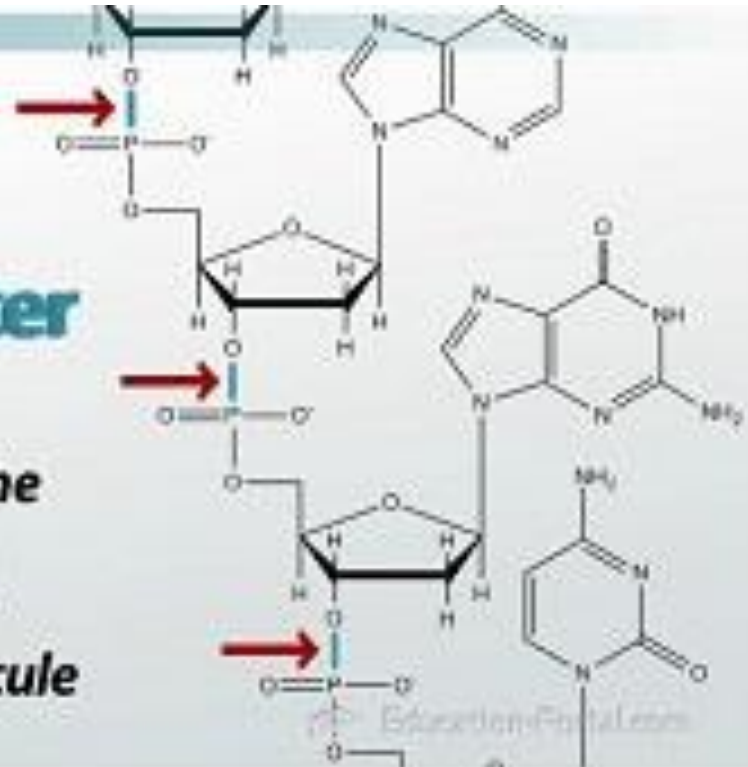
Pyrimidines



PHOSPHODIESTER BONDS

Phosphodiester Bond

the bond between the phosphate group and the sugar in a polynucleotide molecule



Structure of DNA

- In 1869, Friedrich Miescher while studying the nucleus of animal cells found a phosphorus containing material in it. He called it as nuclein.
- Later isolated nuclein from nucleus of pus cells obtained from the used surgical bandages.
- Later it was fractionated into two parts. Acidic and basic part

Structure of DNA

- the base composition of DNA from different organisms vary and is unique for a given organism.
- However, its composition was constant within a particular species and did not vary from individual to individual or from cell to cell within the same individual.
- The number of purine nucleotides always equal to pyrimidines nucleotides.
- Watson and crick proposed famous model of DNA. According to this model, the DNA is present in a double stranded form. The two strands are running antiparallel to each other.
- There are possible three hydrogen bond b/t G and C while only two between bonds can be formed between A and T.

Structure of DNA

- The hydrogen bonds are formed between the NH₂ group of one base and =O of complementary base or between =NH of one and –N of other base.
- For the formation of stable hydrogen bonds, the N-N distance is 0.30nm and O-N is 0.28-0.29nm
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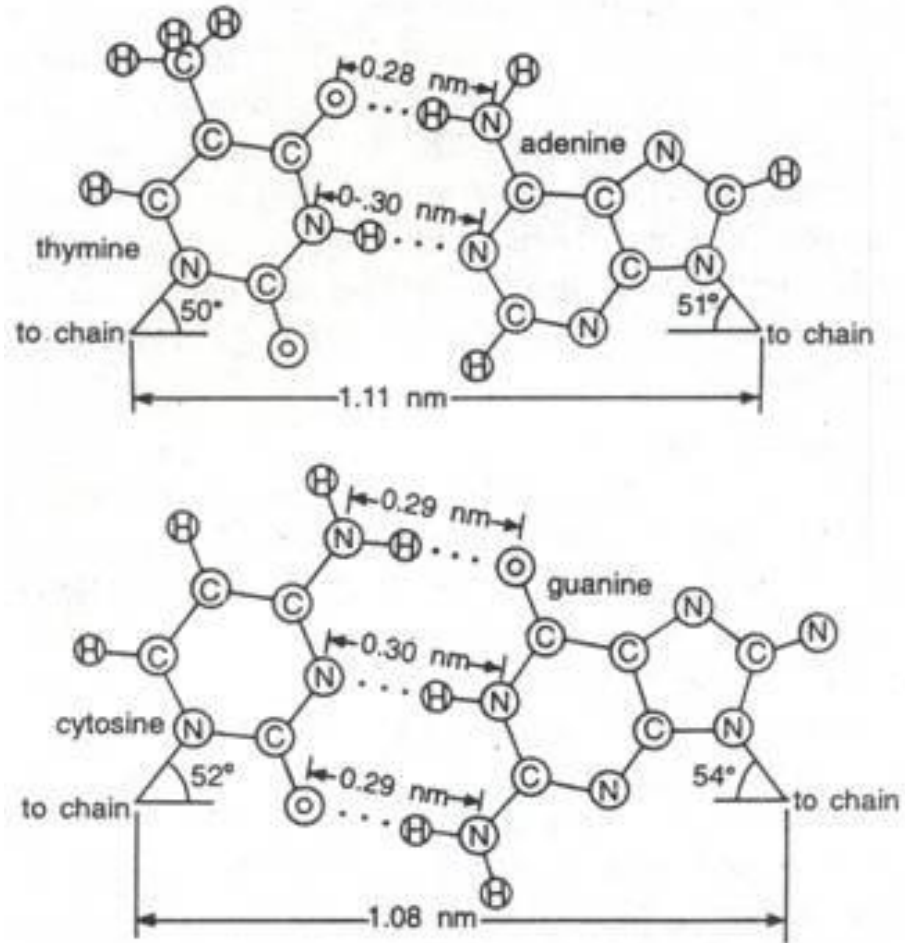
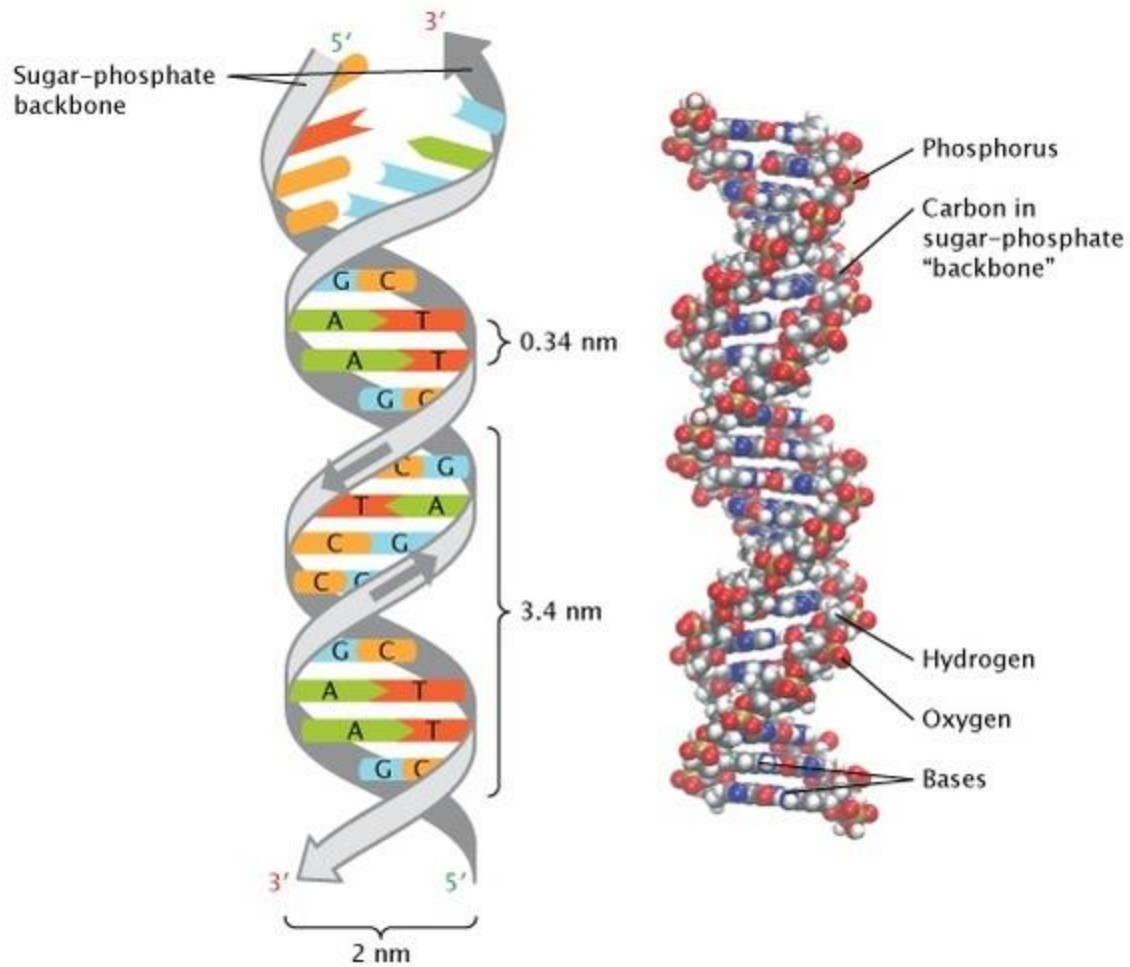


Fig. 3. Two base pairs in DNA. Complimentary bases are T=A and C = G linked with hydrogen bonds.

Structure of DNA

- **two strand of DNA molecule are not present as a linear structure**
- **double helical structure**
- **right hand helix having ten bases in a turn. Each base is thus at an angle of 36° to the adjoining base.**
- **The diameter of helix is 20A.**
- **Three dimensional structure of DNA has two grooves of different size in each turn. Major and Minor grooves.**
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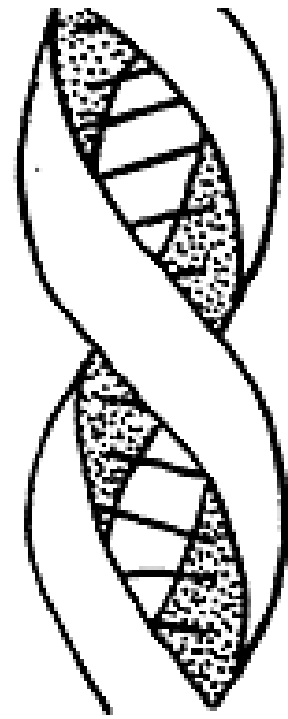
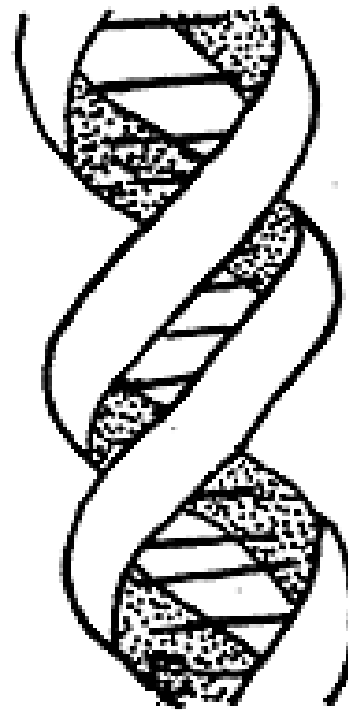
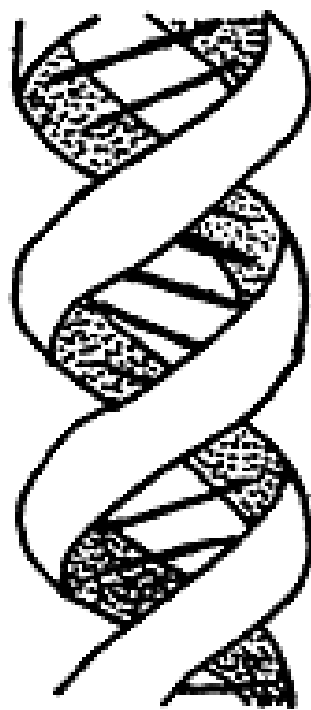


Various forms of DNA

- Majority of DNA of the cell has three dimensional structure as represented by Watson and Crick. This form is B-DNA.
- Small amount of DNA having alternate molecular structure with certain differences from the B-DNA are also present.
- The first alternate structure is that of A form of DNA which varies having 11 base per turn and is more compact.
- A form of DNA has close resemblance with ds RNA.
- Z-DNA has left handed helix. It contain 12 bases per turn and phosphodiester backbone is present in zigzag manner. Define major and minor groove are not present.

Various forms of DNA

- In experimental conditions the existence of z-DNA had been shown in the presence of high salt conditions or in presence of specific cations such as spermine and spermidine.
- It has high degree of negative supercoiling and has certain specific proteins attached to it.
- Besides, there is usually degree of methylation of C residues at the C5 position in the Z-DNA.
- the precise role of alternate forms of DNA is not clear. These may play certain regulatory roles at a site near to them as at the distal sites also. May also play some role in stabilization of DNA.



Form

A

B

Z

helical twist

right

right

left

base pairs per turn

11

10

12

occurrence

RNA, DNA

DNA

DNA

Table 15–6. Comparison of different forms of DNA

<i>Characteristics</i>	<i>A-DNA</i>	<i>B-DNA</i>	<i>C-DNA</i>	<i>Z-DNA</i>
Conditions	75% relative humidity ; Na ⁺ , K ⁺ , Cs ⁺ ions	92% relative humidity ; Low ion strength	60% relative humidity ; Li ⁺ ions	Very high salt concentration
Shape	Broadest	Intermediate	Narrow	Narrowest
Helix sense	Right-handed	Right-handed	Right-handed	Left-handed
Helix diameter	25.5 Å	23.7 Å	19.0 Å	18.4 Å
Rise per base pair ('h')	2.3 Å	3.4 Å	3.32 Å	3.8 Å
Base pairs per turn of helix ('n')	11	10.4	9.33	12 (= 6 dimers)